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VOL. CLIII.—No. 3983] LONDON: FRIDAY EVENING, MAY 13, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

## PUBLIC NOTICES.

### Ceylon Government RAILWAY.

APPLICATIONS are INVITED for the POST of GENERAL MANAGER, CEYLON GOVERNMENT RAILWAY.

| | |
|---|---|
| Headquarters of railway | Colombo |
| Route mileage | 951 |
| Train mileage | 4,984,702 |
| No. of steam locomotives | 286 |
| No. of steam rail cars | 83 |
| No. of coaching vehicles | 917 |
| No. of goods vehicles | 3,409 |
| Personnel | 20,000 |

The Administration of the Railway is in the general charge of a Minister and Executive Committee of elected members of the State Council.

Candidates must be British subjects, and must have held an important administrative or executive position on a railway of approximately the same or greater mileage, and have experience of rail and road co-ordination; must be able to initiate policy, and judge the necessity for extensions, new works, and other matters involving expenditure of public funds; should be, or possess the necessary qualifications to become, a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and/or the Institute of Transport.

Salary: £1600 to £1750 per annum by annual increments of £50.

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The selected candidate will be required to furnish security in the sum of Rs. 15,000 through an approved Guarantee Association.

Free outward passages to Ceylon will be provided for the selected candidate and his family (not exceeding five full passages in all). Leave out of the Island, together with free passages, is grantable under the present regulations after each four-year period of resident service.

Applications bearing the following reference, i.e., M/2918, should reach the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, on or before the 27th May.

Officers in the Colonial Service may submit applications if they so desire, but it is not necessary that they should do so, as their claims will in any case be considered. 8519

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W. S. ANGUS,
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8514 Armstrong College.

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S. C. LAWS, M.A., M.Sc.,
8518 Principal.

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

### Notice is Hereby Given that

SKINNER ENGINE COMPANY, of Erie, State of Pennsylvania, United States of America, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 301,873, granted to them for an invention entitled "Improvements in or relating to Valve Gears for Fluid-pressure Engines."

Particulars of the proposed amendment were set forth in No. 2259 of the Official Journal (Patents), published on the 4th May, 1932.

Any person or persons may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of publication of the said Journal.

W. S. JARRATT.
8515 Comptroller-General.

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## The Engineer

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## PUBLIC NOTICES.

### Swanage Urban District Council

ERECTION OF GROYNES.

TENDERS are INVITED for the ERECTION of FOUR TIMBER PILE GROYNES with North Spurs, and the ERECTION of TWO NORTH SPURS to existing Groynes, the work to be commenced at the end of September.

Drawings of the works may be seen and forms of Tender, general conditions, specifications, and bills of quantities obtained, from the Surveyor, Mr. F. Camble, Town Hall, Swanage.

Tenders, enclosed in sealed envelopes, endorsed "Tender for Groynes," must be delivered to the undersigned not later than Noon on Saturday, 18th June.

The Council do not bind themselves to accept the lowest or any Tender.

THOS. ARNOLD,
Clerk to the Council.

Town Hall, Swanage,
9th May, 1932. 8517

### Wellington (Salop) Urban DISTRICT COUNCIL.

NEW WATERWORKS—CONTRACT E. PUMPING MACHINERY.

The above Council invite TENDERS for the MANUFACTURE, DELIVERY and ERECTION of PUMPING MACHINERY in Duplicate, capable of lifting 5000 gallons per hour against a static head of 108ft., in addition to friction head. The plant is to comprise two Oil Engines and Centrifugal Pumps, together with certain accessories.

Copies of the specification and preliminary drawing may be obtained from the Council's Consulting Engineer, Edward Sandeman, M. Inst. C.E., 15, Victoria-street, Westminster, S.W. 1, upon payment of a deposit of Two Guineas, which amount will be refunded upon receipt of a bona fide Tender, and the return of the above-mentioned documents.

Sealed Tenders, endorsed "Wellington (Salop) U.D.C. Water: Tender for Contract E, Pumping Machinery," are to be delivered to the undersigned by Twelve Noon on Monday, 6th June, 1932.

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G. L. PEACE,
Clerk to the Council.

Bank Chambers,
Wellington, Salop.
9th May, 1932. 8511

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# A Seven-Day Journal

## Wireless on the Cape Air Route.

THE wireless difficulties on the African air route, which were responsible for some of the delays at the opening of the Cape service, are being overcome. It has been found that communication on the long wave length of 900 m. is peculiarly liable to interruption, particularly when there are electrical storms; but experiments that have been made by a Calcutta flying boat between Kisumu and Juba with short and medium waves have shown much better results. When using wave lengths between 20 m. and 45 m. for telephony, the flying boat has been heard and spoken to by stations as far away as the Norddeutsch in Germany and Coltano in Italy, and at the same time the signals were picked up at Johannesburg and Victoria West. The new system has also been tested over short distances, and although a particular wave length cannot at the moment be guaranteed to secure communication when the conditions are bad, it has been possible to find within the range of wave lengths one which seems to meet the requirements. During the short wave experiments communication was maintained up to a distance of about 1000 miles, and from the results already obtained it appears probable that special wireless sets for short-wave communication will be fitted in the new air liners now being built at Coventry for use on the southern half of the Africa route.

## Air Liner Struck by Lightning.

LAST Monday, May 9th, an unusual but by no means unprecedented accident befell the air liner "Horatius," just after it had left Croydon for the Continent. The machine is one of the new Handley Page four-engined aircraft, capable of carrying thirty-eight passengers, which has recently been delivered to Imperial Airways. The accident occurred as it was passing over Tonbridge among heavy clouds at a height of about 2000ft. Immediately after the long wireless aerial had been run out and communication established with the control tower at Croydon the craft was struck by lightning. The damage inflicted was not so serious as to endanger the safety of the machine, but the pilot, as a precautionary measure, at once returned to Croydon, where it was found that the wireless aerial had fused and fallen away, and that the wireless appartaus in the cockpit had been completely wrecked. Some of the windows of the cockpit had been blown out. The air screws of two of the four engines had also been damaged, probably by glass from the broken windows. The port lower air screw was split from tip to boss, and from that on the starboard side a long strip of wood had been torn out of the trailing edge of one of the blades. Similar accidents have occurred to aircraft on several occasions, without serious results, but there is at least one recorded case in which the machine was wrecked.

## The L.M.S. Railway Steamer.

THE new Clyde passenger steamer for the L.M.S. Railway service, which was launched on Thursday, May 5th, at the Govan Yard of Harland and Wolff, Ltd., was appropriately named the "Duchess of Hamilton" by the Duchess of Hamilton herself. The new steamer replaces the "Juno," now being broken up, and will be commissioned early in July. Her principal dimensions are:—Overall length, 271ft.; beam moulded, 32ft.; depth moulded, 10ft. 7in.; and draught, 7ft. 6in. In profile she follows recent Clyde turbine steamer practice, with a straight stem and a graceful stern. She will be propelled by triple-screw turbines taking steam from a double-ended coal-fired Scotch boiler, working under forced draught on the closed stokehold principle. Her propelling machinery has been designed to give her a speed of 20½ knots. In order to facilitate easy manœuvring in narrow waters, both a semi-balanced rudder aft and a bow rudder have been provided. There are in all four passenger decks, two of which are enclosed, one partially enclosed, and one—the shade deck—fully open. The hull and the passenger accommodation incorporate the most modern ideas of ship design.

## Miss England III.

FURTHER details are now available of the design of the new racing motor boat "Miss England III.," which has been built to the order of Lord Wakefield by John I. Thornycroft and Co., Ltd., and which was officially handed over to Lord Wakefield last Monday, May 9th. As given in a Journal note in our issue of April 22nd, her length is 35ft. and her beam as 9ft. 6in. We now learn that the step, fitted to "Miss England II.," which ended in its after section in an acute V, has been modified in the new boat and ends square at right angles to the centre line. The weight-horse-power ratio of the new boat is 3·23, and the engines give 4000 H.P. Two propellers are fitted, each larger in diameter and of coarser pitch than that fitted to the earlier design. They will run at 7000 revolutions per minute. "Miss England III." is now being prepared for her journey to Italy, where she will be tried on Lake Garda. At present she must be regarded as largely experimental, since it is not known how effective the two propellers will be found, nor what improvement may be brought about by the altered design of the step. On Lake Garda she will have the opportunity of competing against other foreign power-driven boats, and if she is found satisfactory it is probable that an attempt will be made to regain the record at present held by "Miss America IX." at 111·71 miles per hour. In any case, after the conclusion of the Lake Garda regatta, "Miss England III." will be brought back to England and any necessary modifications will then be made.

## The Late General Baring.

WE regret to have to announce the death in London last Saturday, May 7th, of Brigadier-General the Hon. Everard Baring, chairman of the Southern Railway Company. General Baring was the fourth son of the first Lord Revelstoke, and was born on December 5th, 1865. He was educated at Eton and Sandhurst, later entering the Army and serving with distinction as A.D.C. to Lord Wenlock, Governor of Madras; in the Sudan operations of Kitchener's campaign of 1898, and as Military Secretary to Lord Curzon in India. His connection with railways began in 1905, when he left the Army, and in 1913 he was elected a director of the Rhodesia and Mashonaland Railways. He was largely responsible for the successful organisation of that railway system. During the war he returned to the Army, finally retiring in 1919 with the rank of Brigadier-General. It was in 1924 that he became chairman of the Southern Railway Company, in succession to the late Sir Hugh Drummond. After his election to this office he relinquished some of his South African interests, but retained his seat on the board of the Rhodesia and Mashonaland Railways. While chairman of the Southern Railway he had many difficulties to face and problems to overcome in connection with the then very recent railway amalgamation. During the long and difficult negotiations that were carried on with regard to the removal of Charing Cross Station to the south bank of the river as part of the great scheme for a Charing Cross bridge, he stoutly defended the rights of the railway shareholders and railway travellers, while, at the same time, he showed that he appreciated the wider and more national principles involved. While he was chiefly concerned with the business side of the various undertakings in which he was interested, he had also much influence on the technical side, and had, for instance, much to do with the extensive electrification of the suburban services of the Southern Railway.

## A National Testing Association.

IN a letter to *The Times* of Wednesday last Sir Owen Williams puts forward the suggestion that a British Standards Testing Association should be set up for the certification of materials constructed to B.S.I. standards. "The time," he writes, "is rapidly approaching when to specify that all materials and workmanship are to be in accordance with the British Standard Specification will be a sufficient specification of everything." The proposed Testing Association would, he says, be given the exclusive right to a mark which would be the hall-mark of materials and manufactures complying with the British Standard Specifications. It should be instituted by industry itself, and would not necessarily displace existing organisations, but would permit them to use the standard testing mark by licence. We may remind our readers that under existing regulations makers of materials and manufactures according to B.S.I. specifications are granted on request permission to put a B.S.I. mark on their products, if the Institution is satisfied that the means employed for examination and testing, either in the manufacturer's works or elsewhere, are adequate and satisfactory.

## The Humber Bridge Scheme.

ON several occasions last year reference was made in this Journal to the great scheme for bridging the Humber at Hull. In November last difficulties were experienced in financing the scheme, owing to the present economic conditions which will not allow of a direct grant being given by the Ministry of Transport. Alternative proposals have recently been made, and are now receiving the attention of the Hull City Council and other interested bodies. The Humber Bridge Committee of the Hull Corporation reports that negotiations with Hambros Bank have taken place, with a view to providing the necessary funds for constructing the bridge. The proposal is that the whole cost be met by an issue of £2,000,000 5 per cent. debentures, redeemable in forty years at par. The absolute control of the bridge would remain in the hands of the Bridge Board, which would borrow the money upon the security of the tolls. The intended expenditure necessary to cover interest and sinking fund charges upon the debenture issue, and to maintain the bridge, would be approximately £13,400 per annum, while the expected yield from the tolls would be £135,000 in the first year, with a progressive increase to £200,000 in 1941. A provision is made that the Corporation and other interested bodies should guarantee any deficiency in the tolls for the first ten years, in order that the sum necessary for all charges and maintenance might be fully assured. The Ministry of Transport and the Treasury have been approached with regard to a Government guarantee in connection with the suggested financial negotiations, and the Minister of Transport has promised to interview the Chancellor of the Exchequer with a view to the desired guarantee being given. Meanwhile the negotiations are being carried on by the Chairman and Deputy Chairman of the Humber Bridge Committee, along with the Town Clerk of Hull.

## Shipyard Wages.

REFERENCE to the wage position in the shipbuilding industry was made by Mr. W. Sherwood, who presided at the annual meeting of the Federation of Engineering and Shipbuilding Trades, which opened at Bournemouth on Monday last. Mr. Sherwood said that the scientific organisation of industry, along with increased activity in rationalisation, had intensified the unemployment problem. The question of the suspension of work on the Cunard liner No. 534 was briefly touched upon, and a loan to assist its completion was advocated. The percentage of unemployment in the shipbuilding industry had reached in some districts, said Mr. Sherwood, the high figure of 71 per cent. For the whole of the industry the average was 58 per cent., while in some districts unemployment in the engineering trades had risen to nearly 40 per cent. Recent reports had indicated that there was about 30 per cent. of obsolete or uneconomic shipping in the British mercantile fleet, and the Federation suggested that such ships should be scrapped and the scrap metal taken over by the Government for later sale at favourable opportunities, thereby providing new work by the possible ordering of more modern ships. With regard to extended schemes of rationalisation and economy, it was held that procedure should be adopted to devise means and ways of transferring men thus displaced into other industries.

## The French Line Cabin Ships.

ON Thursday of last week, May 5th, we were invited by the French Line to inspect at Tilbury the company's motor liner "Lafayette," which visited the Thames while on a short Channel cruise from Le Havre, embracing calls at Tilbury and Amsterdam. The party included representatives of British shipping interests, and was welcomed by Monsieur P. de Malglaive, associate general manager of the Compagnie Général Transatlantique, Paris, with Monsieur P. C. V. Le Brun and Mr. G. C. Rhodes, both directors of the London office of the French Line. Without exception the highest praise was given to the well-designed passenger accommodation, with its pleasingly modern decoration and the excellent arrangements which had been made for the visiting party. The ship carries about 1000 cabin passengers and she holds, we understand, the record for the Atlantic cabin passenger service. There was a large party for this first short Channel cruise, and it seems likely that such cruises will be increasingly appreciated on both sides of the Channel. The "Lafayette" is propelled by a quadruple-screw arrangement of M.A.N. two-stroke double-acting engines with oil-electric auxiliary machinery, and a very neat arrangement of engines, both main and auxiliary, has been adopted. In June the "Lafayette" will be joined by a sister liner, the "Champlaine," which is now approaching completion at the Penhöet yard and works at St. Nazaire. The "Champlaine" is, however, to be turbine propelled, and special interest attaches to her boiler installation, which will incorporate some units of the special boilers designed for the super liner "T 6."

## The Thames Pleasure Steamer Royal Eagle.

ON Monday last, May 9th, we were invited to inspect at the Tower Pier the new Thames pleasure steamer "Royal Eagle," which, to-morrow, Saturday, May 14th, will make her maiden trip in the General Steam Navigation Company's Margate and Ramsgate service. The principal dimensions of the ship were given in a Journal note of February 26th, when her launch from the Birkenhead yard of Cammell Laird and Co., Ltd., was recorded. She has been designed and constructed under the personal supervision of the owners' consulting architect and marine surveyor, Mr. William Gray, and our inspection indicated that a design suited in every way for her service has been achieved. There is plenty of both open and covered deck space, and private as well as public dining and smoke-rooms have been arranged. The engine and boiler-rooms are neatly arranged, and we noted that the level of the paddle shafts has been so chosen that there is very little rise in the deck immediately above them. As previously recorded, the propelling machinery comprises a diagonal triple-expansion engine, with Walschaerts gear and piston valves, steam being raised in two single-ended four-furnace Scotch boilers, which are oil-fired on the Wallsend-Howden principle, and work at a pressure of 210 lb. The auxiliaries include a complete range of Weir air pumps, feed pumps, and feed-water heaters, also steam-driven electric generating plant and a small oil-engine standby set and the usual service pumps. During the voyage round from Birkenhead to the Thames, the new ship showed, we learn, excellent steaming and manœuvring characteristics with a good fuel economy.

# Transient Voltage Stresses in Power Transformers.

By K. K. PALUEFF.

No. III.*

## Mechanism of Cumulative Oscillations.

If, instead of a single travelling wave, a train of waves equal in amplitude, but alternating in polarity, is applied to any oscillatory circuit, two types of phenomena may result. If the waves follow each other at such intervals that the oscillation due to each impulse has died out before the next arrives, then obviously each impulse will produce oscillations of identical amplitude. But, if the oscillation due to one impulse has not died out before the next arrives, then the oscillation due to the latter impulse will combine with that due to the former. Since the internal oscillation in a transformer may consist of ten or more harmonics, this combination will result in a decrease in amplitude for some harmonics and an increase for others. If the time interval between succeeding impulses approaches half the period of one or more of the natural frequencies of the circuit, a train of waves will produce cumulative oscillations of resonance, resulting in very high internal voltages. Here again an analogy with the elastic ribbon may be helpful. Successive impulses even of small amplitude will create violent oscillation of the ribbon, if these impulses are applied at the proper frequency. No trains of rectangular waves are experienced in service, except on very rare occasions. However, damped oscillations produced by switching, arcing earths, and flash-over of line insulators by lightning are common on all systems.

Since oscillations can be looked upon as a train of waves, it is obvious that an oscillation at a frequency near that of one of the natural harmonics of a transformer will produce cumulative internal oscillations similar to that described above. This growth of amplitude is illustrated by the oscillograms in Fig. 17 *ante*. It must be appreciated that exact coincidence between the frequency of the applied oscillation and the natural frequency of the circuit is not at all necessary to cause an appreciable growth of amplitude of the internal oscillations. For example, in the above oscillogram, there is a difference of 20 per cent. between the frequency of the applied voltage and the nearest frequency of the transformer. In addition, the applied oscillation is highly damped. In spite of these facts internal voltages have been created which have four times the amplitude of the applied wave. Furthermore, it is essential to remember that only a few cycles of highly damped oscillation are sufficient to build up these high voltages, as is evident from the same figure.

In Fig. 18 *ante* a switching surge is shown produced by de-energising a 70-mile 132,000-volt overhead transmission line. It illustrates two essential characteristics. First, the switching surge consists of a complex oscillation. For example, analysis of this wave shows that it consists of about six harmonics of practical importance. Secondly, the oscillation persists for a number of cycles. Incidentally, it is interesting to note that the damping of the fundamental harmonic of this surge is of the same order as that of the applied wave of Fig. 17. The harmonic analysis of the switching surge shows that the amplitude of the third half cycle of the fundamental harmonic is 59 per cent. of that of the first, while the third half cycle of the applied wave of Fig. 17 is 56 per cent. of the first. The frequency of the fundamental harmonic of a switching surge or arcing earth depends principally upon the length of the transmission line, and covers a range from about 200 to 10,000 cycles per second. The lower natural frequencies of many transformers are within this same range.

## Probability of Failures.

The question may be asked, why if the danger from transient voltages is as serious as is outlined in this article, are there so relatively few failures in service? The writer does not possess sufficient statistical data to state just what percentage of the total transformers fail in service, owing to transient voltages, but several considerations may explain why this percentage is small. It is hoped that this analysis will also show that in regard to transient voltage stresses a satisfactory service record does not prove the reliability of a given construction. Since practically all power transformers with earthed neutrals are now subjected in the standard acceptance tests to 3·46 times normal phase voltage at the line end, the insulation to earth at that point can be assumed to be the same in all transformers of a given voltage rating, irrespective of type or manufacture. Choice of the remainder of the major insulation and also insulation between coils and turns is left to the discretion of the manufacturer as long as it is capable of standing the stresses produced by acceptance tests, which are negligible in comparison with transient voltages found in service. Therefore the difference in lightning strength of transformers of different types is caused by difference in the safety factor employed in the selection and distribution of internal insulation.

The discussion of transient voltage phenomena in current literature reveals the fact that few designing engineers know the phenomena quantitatively. The exaggerated ideas expressed by some designing engineers in regard to the outstanding benefits of the "electrostatic ring" and of "scientific" selection of capacitance between turns at the line end, as well as the erroneous interpretations of the effect of very wide coils—as used in shell type transformers—on initial voltage distribution and subsequent oscillations, serve to illustrate this fact.[10, 11] Considering this fact, as well as the types of construction recommended by such engineers, and service experience of transformers of many makes, diagram 1A of Fig. 19 was

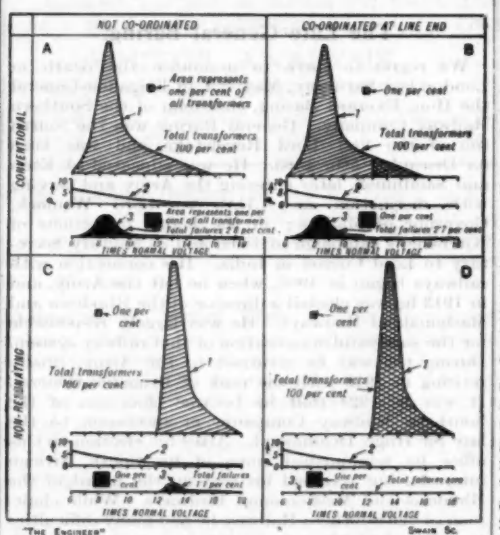


**Fig. 19**

**Probability of Transformer Failures Due to Lightning Waves. 1.—Shaded Area Represents Total Number of Transformers in Service. Abscissa Represents Lightning Strength in Multiples of Normal Phase Voltage (Crest). Area at the Left of a Given Voltage is Proportional to the Number of Transformers that will Fail at Application of that Voltage. Crosshatched Area Represents that Portion of Total Number of Transformers Made Immune from Lightning Failure by Co-ordination of the Insulation of the Line End of Transformers and the Transmission Line. 2.—Per Cent. of Total Transformers in Service Struck by Lightning Waves with Amplitude in Excess of that Indicated by Abscissa. 3.—Area Shown in Black Represents Total Number of Transformer Failures.**

constructed, which is, of course, necessarily hypothetical. This diagram is based on the following assumptions:—(1) That all transformers will stand, at the line end, 3·46 times normal phase voltage at operating frequency, corresponding to a lightning voltage El of about twelve times normal phase voltage. (2) The major insulation between winding and earth is graded down toward the earthed neutral; and (3) that transient voltages produce internal oscillations as outlined in this article.

Thus the minimum voltage that need be applied to a given transformer of any conventional type with graded insulation, to cause failure, is determined by the minimum ratio found anywhere in the winding between insulation strength and respective maximum transient voltage stress. For example, suppose it is desired to find the minimum voltage that would cause breakdown to earth in a transformer with graded insulation strength shown by line 9 and maximum voltage to earth shown by curve 8 of Fig. 13 *ante*. A curve of ratio of ordinates of 9 to those of 8 should be plotted—curve 10, Fig. 13. This curve shows that in this case the minimum ratio is found near the neutral and is 0·28. This means that the failure will take place there if the applied voltage is in excess of 28 per cent. of the breakdown voltage of the insulation at the line end. Curve 11—Fig. 13—represents the ratio of the ordinates of curve 7 over curve 8. Curve 7 shows the grading of the insulation found by Mr. Floyd[12] in a shell type transformer. It was also assumed in diagram 1A of Fig. 19 that internally all transformers can stand stresses produced by an applied voltage of at least six times normal phase voltage—crest—and none can stand more than eighteen times normal voltage. Limiting the investigation to the probability of failure from lightning, Fig. 20 shows a classification of lightning waves by their amplitude at the point of origin. It is computed from the result of several years of field observation on four characteristics high-voltage transmission systems in the United States.[13]

To arrive at a most probable value of the number and amplitude of lightning waves striking transformers on each end of a line, a hypothetical 100-mile, 132,000-volt transmission line has been taken with insulation allowing a maximum lightning voltage of 1,600,000 volts—twelve times normal line voltage—and with attenuation characteristics within the limits found in practice. As has been shown in a previous publication,[14] the impedance offered to a surge by a transformer is so high that travelling waves striking a transformer suffer almost complete reflection. As a result the voltage at the transformer is twice that of the incoming wave, but, of course, never more than the lightning strength of the line insulation, 1,600,000 volts. Further, it was assumed that lightning storms were uniformly distributed along the line. From these considerations, curve 2, diagram A, of Fig. 19 was constructed, which shows the relation between the amplitude and number of waves striking the transformers, expressed in per cent. of the total number of waves which originate on the line of amplitude not less than 2½ times normal voltage. The high attenuation of lightning waves is responsible for the fact that only such a small percentage of the total storms produce voltage at the transformer terminals in excess of five times normal.

To determine the probable number of failures of transformers, it is necessary to find the most probable number of the transformers shown in curve 1, diagram A, of Fig. 19, which would be struck by waves—curve 2, diagram A—above their breakdown voltage. By the law of probability this number is the product of curves 1, diagram A, and 2A. The result is shown in diagram 3A, in which the area represents the total number of failures and their distribution in regard to lightning strength of the transformers that failed—1A and 3A are drawn to different scales, as shown. The conclusion is that even with transformers as weak as shown by 1A of Fig. 19, and with the lightning strength of the line practically twice the strength of the majority of transformers, the percentage of failures is small. Therefore the manufacturers of such transformers take but a small chance, and can well afford the risk, particularly if it gives them some other advantages. However, the purchaser of the transformers can get but little consolation from the fact that the failure of his transformers, and consequent interruption of service, is small, if expressed in per cent. of all transformers in existence and total kilowatt hours in all systems of the world. It may appear that lightning failure of the transformers of conventional types may be prevented by making the lightning

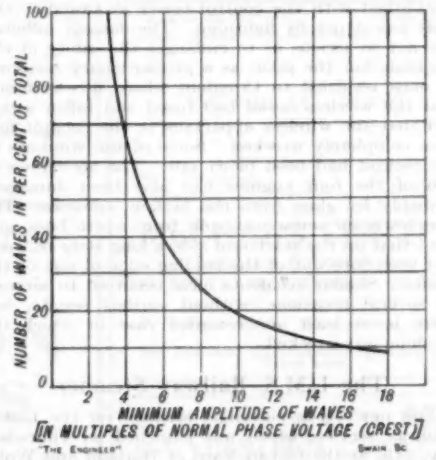


**Fig. 20**

**Classification of Total Lightning Waves with Respect to Amplitude at Point of Origin. All Waves Less than 3 Times Normal Voltage have been Disregarded.**

strength of the adjacent line—or of a protective gap—less than that of the transformer winding at the line terminal. It would appear that it should prevent application of voltage beyond the strength of the transformer.

That such is not the case is evident from examination of 3B of Fig. 19, which shows the number of transformers that would fail in case the line—or gap—insulation were made to arc over at lightning voltages of twelve times normal. It should be remembered that we assumed all transformers to be capable of withstanding such a voltage to earth near the line terminal. It is obvious that only those transformers will be protected by the co-ordination which have enough insulation internally to stand the stresses produced within the winding by such a terminal voltage. Accordingly, in diagram 1B, Fig. 19, the shaded area of the right-hand corner corresponds to a number of such transformers. All transformers outside of this area are susceptible to failure in spite of the fact that in accordance with curve 2, diagram B, the maximum voltage is below the transformer strength near the line terminal. It appears that limitation of lightning voltage by means of co-ordination to maximum of twelve times normal reduces failures only from 2·8 per cent. to 2·7 per cent.

It follows that all transformers that would fail under such a circumstance would not fail at the line end, but would fail internally either to the low-voltage winding or earth—in case of major insulation being graded—or between turns and coils. It also follows

* No. II. appeared May 6th.

[10] "Effect of Surges on Transformer Windings," J. K. Hodnette, A.I.E.E. Quarterly "Trans.," Vol. 49, January, 1930, page 68; and K. K. Paluefl's discussion.

[11] "Transformer Design," Part 1 and 2, E. T. Norris, the *Electrical Review*, January 23rd and 30th, 1931.

[12] "Co-ordination of Insulation as Design Problem," G. D. Floyd, A.I.E.E. "Trans.," October, 1930.

[13] "Summary of Five Years' Work in the Study of Lightning Effects on Transmission Lines," W. W. Lewis, International Conference on Large High-tension Systems, Paris, 1931.

[14] "Lightning Studies on Transformers by the Cathode Ray Oscillograph," F. F. Brand and K. K. Paluefl, A.I.E.E. Quarterly "Trans.," Vol. 48, July, 1929, page 998.

that even where no co-ordination is accomplished, at least $\frac{2\cdot7}{2\cdot8}\times100=97\cdot8$ per cent. of transformers that failed would fail internally. If a transient voltage is distributed uniformly along the winding, the voltage between any two points is the same fraction of the lightning terminal voltage, as the voltage that appears between the same points during induced voltage acceptance tests is of the terminal voltage of that test. Since it was assumed that insulation which stands 3·46E will stand lightning voltage of twelve times normal, the obvious conclusion is that a transformer that is capable of withstanding an induced voltage of 3·46E and distributes transient voltages uniformly will be able to withstand a lightning voltage of twelve times normal. Diagram 1C of Fig. 19 was constructed for the condition that all

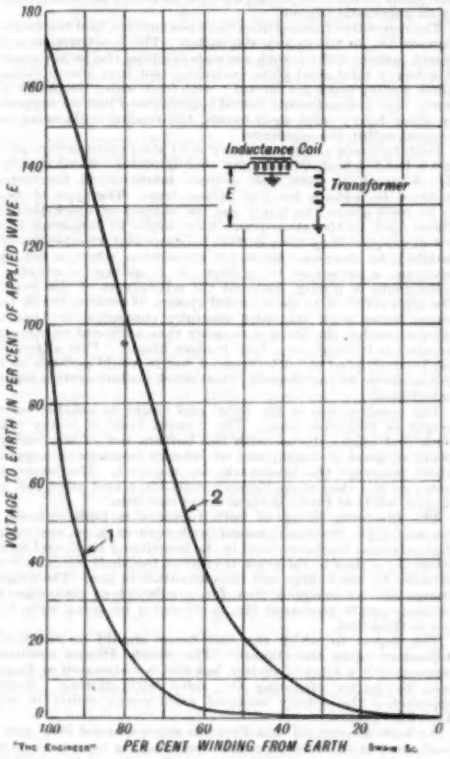


FIG. 21

Effect of Inductance Coil on Initial Voltage Distribution in Transformer Winding (Test Results). 1.—Initial Distribution with Transformer Connected to Line Directly. 2.—Initial Distribution with Transformer Connected to Line Through Inductance Coil.

transformers distribute voltage uniformly and receive a test of 3·46E. Diagram 3C shows that only 1·1 per cent. of the transformers would fail in such a case. This would happen when lightning voltages in excess of 12E are applied.

In addition, should the line insulation be co-ordinated by means of a gap near the transformers, so that the voltage appearing across the transformers would be limited to twelve times normal, curve 2C would be replaced by curve 2D, and the resultant failures would become zero. It, of course, is understood that the assumptions which had to be made in arriving at these conclusions make the results only approximately correct, and they are not intended to give values for the actual number of failures in service. However, it is hoped that they show quite clearly that no conclusion regarding the ability of a given construction to withstand lightning can be drawn from a satisfactory service record, unless the magnitude and shape of lightning waves actually applied to the transformer in service are known.

### External Protective Devices.

To be practical, any device protecting apparatus against transient voltages should satisfy the following requirements:—(1) It must give protection against impulse waves of characteristics found in practice by reducing such transient voltages below the safe insulation strength of the apparatus protected; (2) this reduction of transient voltage should be effected without permitting too abrupt a change of voltage on either the front or the tail of the transient wave; to prevent uneven voltage distribution in inductive windings the length of front and tail must not be less than the period of the fundamental natural frequency of the winding; (3) no interference should be offered to the normal power current of the system; (4) no hazard should be added to the maintenance of service; (5) its own strength against lightning damage, internally or externally, should be higher than that of any adjacent apparatus or insulators, and it should not be injured by a system short circuit or by other disturbances. There are two general types of protective devices:—(1) Lightning arresters of various kinds; (2) series impedances. Lightning arresters are widely known and applied, and recent advances in their characteristics enable them to meet the above requirements more satisfactorily than hitherto. The electrical characteristics of many arresters have been published, and the exact performance of some of them—like Thyrite—can be computed analytically from published date.[15, 16] The success of devices of the second type depends upon their ability to prevent, to a considerable degree, the passage of surges to the protected apparatus, or to modify the shape of the surge so that it will not create, or at least will materially reduce, the internal oscillations. For a great many years many believed that a pure inductance in series with a transformer served as an excellent barrier to high-frequency transients. It has been shown,[17] that this is not the case, and that such an inductance can materially increase the stresses within the windings of transformers or other inductive apparatus.

Recently there has appeared on the market a device which is intended to serve as a surge absorber. It consists of an inductance coil—primary winding—closely coupled with a short-circuited and earthed secondary—casing or tank. The primary winding is connected between the transmission line and the apparatus to be protected. Sufficient data on the high-frequency electrical characteristics—inductance, capacitance, resistance—of this device have not yet been published. No oscillograms of its performance and its effect on transformer oscillations have been shown. For this reason it is quite impossible to arrive at a definite conclusion regarding the effectiveness of this device. The claim made by the manufacturers is briefly:—That owing to dissipation of the energy of the surge in the absorber, caused by the extremely high eddy loss of the secondary, and owing to the effect of the inductance and capacitance of the device on the shape of the surge, the stresses within transformer windings are greatly reduced. The protective

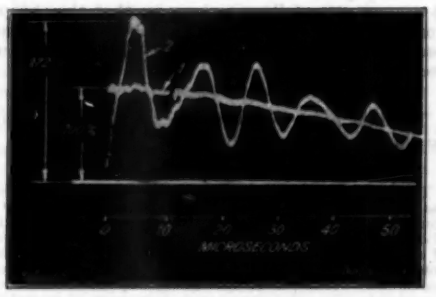


FIG. 22

Effect of Inductance Coil (·0057 Henrys Placed in Earthed Metal Shell) on the Terminal Voltage of a Transformer. 1.—Wave Applied to Inductance Coil in Series with Transformer. 2.—Resultant Wave Across Transformer.

value is claimed to be substantially superior to that of the best lightning arresters. The ratio of the voltage $e_1$ across the line end coil of a transformer, measured with the absorber connected, to the corresponding voltage $e_2$, measured without the absorber connected, is put forward by the manufacturers as the sole criterion of its effectiveness. The value $\left(1-\frac{e_1}{e_2}\right)$ is suggested as the "coefficient of absorption," and as the measure of protection attained.

It appears to the writer, however, that such a criterion is very unsatisfactory. A plain inductance coil with negligible capacitance to earth—say, 0·0005 m.f.—and negligible energy dissipation, can give the same value for this coefficient. The initial voltage distribution obtained in a power transformer without a series inductance coil is shown in curve 1 of Fig. 21. The voltage $e_2$ across the coil at the line end of the winding—2 per cent. of the winding—is 16 per cent. of the applied voltage E. With an inductance coil in series, an oscillation due to its inductance and the transformer's capacitance combined with the effective capacitance of the coil to earth may cause the voltage across the transformer to rise rapidly to a value much higher than that of the applied wave. For example, in Fig. 22, curve 2 indicates an increase of 72 per cent. in the voltage applied with the inductance in the circuit. This results in the initial voltage distribution shown by curve 2, Fig. 21. In this case, $e_1$ across the line end coil is only 5·5 per cent. of that applied. This gives a "coefficient of absorption" of $(1-5\cdot5/16)=0\cdot66$, which would indicate that 66 per cent. of the surge had been "absorbed." In reality, the stresses throughout the other parts of the winding have not been reduced, but have been materially increased, as shown on Figs. 22 and 23. In this test, to increase the high-frequency eddy loss, the inductance coil of 0·0057 henries, about six times that of a typical "surge absorber," was placed in an earthed round iron tank, the distance $d$ between coil and tank wall being made as small as insulation requirements for 66 kV operation permitted.

[15] "Thyrite, a New Material for Lightning Arresters," K. B. McEachron, A.I.E.E. "Trans.," Vol. 49, April, 1930, page 410.

[16] "Field Tests on Thyrite Lightning Arresters," K. B. McEachron and E. J. Wade, A.I.E.E. "Trans." Vol. 50, January, 1931, page 479.

[17] "Effect of Transient Voltages on Power Transformer Design," K. K. Palueff, A.I.E.E. Quarterly "Trans.," Vol. 48, July, 1929, page 681.

From these facts it can be concluded that by using an inductive device in series with a transformer, it is possible to shift the stresses to different parts of the winding without necessarily reducing them, and it is therefore necessary to measure the voltage distribution throughout the winding with and without a protective device, to secure a true value for the protection obtained. Needless to say, this distribution will change considerably with a marked change in the shape of the applied wave, and these tests should be made with many waves, covering the extreme range of shapes and lengths found in practice. If the effective inductance of the absorber is made negligible, it can have little effect on the shape of the wave passed to the transformer, whilst if the inductance is appreciable it will increase both the terminal voltage of the transformer—Fig. 22—and internal stresses in the winding, owing to resonance of the terminal voltage wave—Fig. 23—with harmonics of the wind-

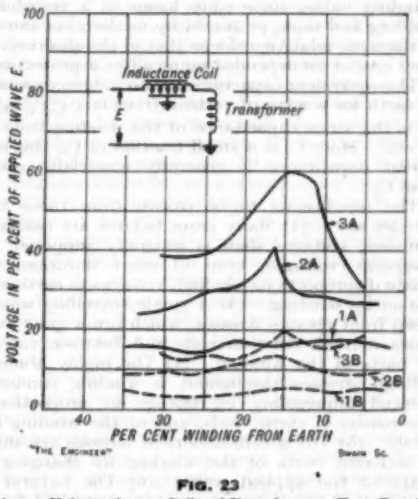


FIG. 23

Maximum Voltage Across Coils of Transformer (Test Results). 1.—Voltage Across One Coil. 2.—Voltage Across Two Coils. 3.—Voltage Across Three Coils. A.—Inductance Coil in Series with Transformer. B.—Transformer Connected to Line Directly. The Applied Wave "E" is the Same as that Shown in Curve 1 of Fig. 22.

ing. Furthermore, the primary coil of the absorber would oscillate internally in the same way as a transformer winding, and this would make the problem of insulation of the absorber winding practically identical with that of a transformer winding.

As to the effect of capacitance between the earthed tank and primary winding of the absorber on the shape of the incident wave, the capacitance of a winding to earth at low frequency is proportional to $\frac{S}{d}$, where S is the surface of the winding facing the earthed parts, and $d$ is the distance from winding to earth. Since the insulation used in transformers is the best available, it follows that the distance $d$ for a surge absorber must be at least as great as the corresponding distance in a transformer, and preferably it should be greater to give an additional factor of safety. Because of the small size of the absorber its surface S must be smaller than the corresponding surface in a transformer. The capacitance $C_y$ to earth at low frequency, which is proportional to $\frac{S}{d}$, must, therefore, be smaller for an absorber than it is for a transformer.

It appears from the foregoing that such a device by itself can neither reduce the voltage of a wave nor can it slant its front. If combined with an overhead transmission line surge impedance, it will act as a very small capacitance—say 0·0001 to 0·001 m.f. or thereabout for high-voltage absorbers—and it will not therefore reduce the amplitude of the wave, but will slant its front very slightly. In case of an underground cable being used in place of an overhead line, its surge impedance is generally less than one-tenth of the latter and even this slight slant will become imperceptible. In either case the effect on the stresses throughout the transformer winding will be very small. Since the surge impedance of the line can be neglected when lightning strikes a line near a transformer, a surge absorber will cause the voltage across the transformer to rise above that of the surge—2, Fig. 22.

It is possible that the capacitance to earth in an absorber for the higher operating voltages is so small that the combined effect of its capacitance and of the surge impedance even of an overhead transmission line, will not slope the front of an incident wave sufficiently to prevent the rise of voltage across a transformer to a value higher than that of the incident wave. It appears that the equivalent capacitance to earth for a safely designed absorber must be of the same order of magnitude as that of a transformer. It is a generally recognised fact that the electrostatic capacitance of a transformer winding, including that of the entrance bushing, is too small to have a noticeable effect on the shape of an incident wave, and it follows that the capacitance to earth in an absorber can have but small effect on the shape of a wave.

This is particularly true for absorbers for high operating voltage, where oil must be used for insulation and the distance *d* between the winding and tank is necessarily materially greater than in low-voltage absorbers. In a non-resonating transformer the equivalent capacitance of the transformer to earth is increased many times by the presence of shields. It is believed that this capacitance is considerably greater than that found in oil-insulated absorbers, but it is still much too small to slant the front of an incoming wave appreciably or to reduce its amplitude. Of course, whether the front is slanted or not is of no importance to this type of transformer, and, furthermore, the purpose of the shields is to distribute capacitance correctly and not to increase its value. It is obvious that if it is capacitance effect that is desired to be obtained by an absorber, it could be done much better by means of a simple capacitor. The effect of high-frequency eddy losses on the amplitude of a surge passed through an absorber cannot be of outstanding value, since eddy losses in a transformer winding and tank, produced by oscillations, must be of the same relative order as that of the absorber, and they cannot be depended on at all as a protection.

The equivalent capacitance of an inductive winding to earth for a wave of vertical front is $\sqrt{C_s C_g}$, where $C_s$ is the series capacitance of the winding from end to end. Since $C_s$ is a small fraction of $C_g$, this equivalent capacitance is generally materially smaller than $C_g$.

The conclusions to be drawn from these three articles are :—(1) Many more failures are caused by transient voltages than is generally supposed. (2) Transient voltages, even of short duration, may create disproportionately high voltages to earth along the entire winding. (3) A single travelling wave of steep front creates stresses, which are a great many times normal, between coils and between turns in all parts of the winding. (4) The highly abnormal voltage stresses throughout a winding cannot be reduced appreciably by change in proportion of dimensions of turns, coils, and of the winding as a whole. (5) The severe abnormal stresses are shifted to different parts of the winding by changing the shape of the applied wave. (6) The natural frequencies of transformers are not controlled by the designer. Their range coincides with that found for transient voltages on transmission systems. (7) Even very highly damped oscillations of relatively low amplitude, if applied to a transformer, may create internal stresses equal to, or in excess of, those produced by lightning. (8) Grading of insulation between the high-voltage winding and other parts, such as low-voltage winding and core, effects considerable saving in the cost of a transformer. (9) Such grading of insulation is allowed by the distribution of voltage stresses during standard "induced voltage" tests, as specified by the B.E.S.A. and A.I.E.E. However, it is not justified by the distribution of stresses produced in service by transient voltages. (10) Certain parts of the winding are subjected to stresses in service many times as great as the stresses applied during the induced voltage tests—compare curves 1 and 2 of Fig. 2 *ante*, as well as curves 2 and 4 of Fig. 3. The law of probability, combined with field data, indicates that many inferior transformers may operate satisfactorily in service for an indefinite period, but they are liable to failure at any time. (11) Co-ordination of line insulation to correspond to the transformer strength at the line end of the winding does not insure freedom of transformers of ordinary construction from transient voltage failures. (12) A co-ordination such as the foregoing prevents failures of transformers having uniform distribution of transient voltages. (13) "Coefficients of absorption," as are determined for some surge absorbers, may be very misleading, since they may indicate a shift and increase rather than a reduction of stresses; and (14) it appears most probable that the "surge absorber" offered on the market does not absorb a sufficient amount of energy to serve as a protective device, and may, under stated conditions, appreciably increase surge voltages.

*(To be continued.)*

# The Iron and Steel Institute.

No. I.

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Westminster, London, on Thursday and Friday, May 5th and 6th.

On the morning of May 5th, the President, Colonel Sir Charles Wright, took the chair, and the first business was the consideration of the annual report of the Council, which was taken as read.

Sir Harold Carpenter, Hon. Treasurer, then presented the accounts for the past year and referred with satisfaction to the fact that for the first time for three years there was a surplus to be carried forward. It amounted to £94. During the year it had at last been possible to re-establish the claim of the Institute for exemption from income tax. For many years the Institute enjoyed immunity from income tax, but in 1927 the exemption was abrogated. The Commissioners of Inland Revenue, however, had now been convinced of the justice of the claim of the Institute for exemption.

### THE BESSEMER MEDAL.

The President then presented the Bessemer Medal to Professor Henry Louis, who, he said, was one of that band of eminent men who were trained at the Royal School of Mines under Dr. John Percy. He recalled that much of Professor Louis' experience was gained in South Wales, and that for a time he worked under his (the President's) father, who at that time was associated with Dr. William Siemens at the Landore Steel Works near Swansea. In 1896 Dr. Louis was appointed to the Chair of Mining in Armstrong College, in the University of Durham, and was the first to introduce elementary metallurgy and metallography as a part of the curriculum of naval architecture and engineering, other universities soon following that example. Since his retirement Dr. Louis had continued to take a great interest in mining problems and one of the most important was the question of the use of steel supports in mines in replacement of timber.

Professor Henry Louis, expressing his appreciation of the honour conferred upon him, said perhaps the most important part of his work had been concerned with the extraction of the crude material for the iron and steel industry and its preparation in what he had ventured to consider was the most suitable form for use in the industry. Looking at some recent figures, it seemed that the average consumption of fuel in this country was 50 per cent. higher per ton of pig iron than the average consumption of fuel in Germany. That showed that we had a good deal yet to do, and he suggested that one of the ways of getting the consumption of fuel down—and therefore to cheapen the product—was by taking care that the materials put into the blast-furnace were presented in the best possible physical and chemical conditions for reaction. It was an utter fallacy to suppose that the cheapest iron ore necessarily made the cheapest pig iron; many other considerations had to be taken into account.

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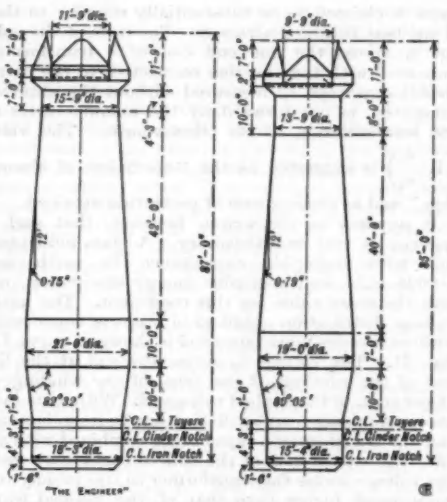
The first paper read was on "Blast-furnace Engineering," by Major W. R. Brown.

### BLAST-FURNACE ENGINEERING.

This paper deals principally with the Dagenham Furnace of the Ford Motor Company, Ltd., and the Pretoria Furnace of the South African Iron and Steel Industrial Corporation, Ltd. It deals first with general considerations that affect the lay-out of a blast-furnace plant and observes that the Ford Motor Company considers that contiguity of plant is an essential desideratum. Hence all components of its plant are disposed in a minimum space and unnecessary movement of materials is strictly avoided. At the Pretoria plant, where the industry is naturally in an embryonic stage, considerable freedom has been reserved, and the plant is somewhat more widely distributed.

One of the initial problems of engineering proper being the foundations, it is strange to note how widely variant were the conditions at these two plants. At Pretoria, the difficulties




FORD FURNACE PRETORIA FURNACE

were negligible, but at Dagenham an exceedingly complex problem presented itself, since every load must be carried on piles, those used being 14in. square of pre-cast reinforced concrete. At Pretoria, where the ground will carry a load of from 2 to 8 tons per square foot, no piling has been necessary. On the other hand, there exists at Pretoria a climatic condition which must be carefully heeded: the low barometric pressure due to altitude. Turbo-blowers, air fans on stove burners and the like must be proportionately increased in size in comparison with sea level machines if they are to deliver a similar weight of air or oxygen. Coming to plant engineering, the author points out that a minimum size of furnace exists below which it would be uneconomical to use the expensive mechanical equipment which one associates with a modern plant. This size should not only be expressed in terms of output of iron, where between 350 and 500 tons per day would be the datum, but in certain cases a more correct medium of expression is terms of total material input. The postulation would then be that about 1000 tons per day of input warranted mechanisation, although in the case of lean ores this might represent only 200 tons of iron output per day.

Both the furnaces reviewed are destined to make 500 tons of iron per day, although the commencing outputs may be in the neighbourhood of 350 tons. The objective at Dagenham is to produce a high-silicon special iron and to maintain the grade without intermission. For this purpose it was decided to be generous with the volumetric capacity and drive at only a moderate speed. Pretoria, on the other hand, aims to make basic, foundry, or special irons on a very rich burden, and the dimensions of the furnace conform closely to established precedents for this kind of production.

For the electric current actually used in plant operation it is wise to limit the voltage to 230 to 250 D.C. In arriving at this decision safety to *personnel* should be the chief consideration, and a referendum of the opinions of American engineers, experienced in running highly mechanised plants, unanimously supports this judgment.

The particular undertakings under review have their widest point of difference in the manner in which their raw materials are received. At Dagenham there has been made a very thorough effort to extract the maximum monetary advantage by rapid discharge of the ships carrying ore, coal, and limestone. The wharf arrangements are the most up-to-date in the Port of London, and can accommodate ore-carrying vessels up to 12,000 tons. At the Pretoria plant very different circumstances prevail; here all incoming supplies are rail-borne. Coal goes direct to the coke ovens, and so is not directly related to the engineering problems of the blast-furnace. Ore and limestone pass through the crusher plant and are delivered by belt to hoppers superimposed above the tracks which traverse the tops of the furnace bunkers.

Coke at both furnaces is conveyed by belt from the preparation plant at the coke ovens, and the furnace bunker is trimmed by an automatic tripper.

The respective furnace lines have ten tuyeres, and the Pretoria furnace has an emergency slag notch. The construction of the hearth jackets differ; with sea water cooling the jacket consists of a heavy mild steel plate encircling cast iron staves through which cooling pipes are carried; with fresh water the jacket is of heavy cast iron segments bolted together and further supported by three heavy mild steel bands, the cooling coils being cast integral within the segments.

Both furnaces employ a heavy mild steel plate tuyere jacket and a banded bosh with copper cooling plates. Shaft cooling is also common to both, but is more intensive on the furnace destined to make a hot high-silicon iron. The type of cooler to be used above the lintel was the subject of much thought. Those open to the atmosphere have much to commend them, but in practice they have certain fundamental weaknesses. The inability to increase the water circulation when a hot spot develops, a proneness to spillage, or if spillage is avoided, a multiplicity of piping, discount the advantages of this system. The alternative is to use a closed system of coolers, fed in horizontal series with the inlet carefully controlled so that the pressure within the block is no more than sufficient to carry the circulation through, say, four cooling blocks. This alternative has been adopted at both furnaces, but it would perhaps be not unreasonable to say that the ideal stack cooling system has yet to be found.

The construction of the lintel and casing is notable for the weight of materials used. The former, built of heavy plate-work and angles, forms with the bottom tier of the casing a girder of great strength, and no interior brackets or supports, which interrupt the brickwork, are required. The larger diameter of the Dagenham furnace calls for a cast steel bell and hopper, while at Pretoria these are of cast iron.

The fire-brick lining of both furnaces is built entirely of 9in. and 13½in. machine-pressed brick squares, keys, and arches. High-alumina bricks are used in the hearth and bosh, and special attention is paid to the grain texture of the shaft lining to resist abrasion by the charge and impenetration of gas. The original linings are so designed that for a subsequent campaign the furnaces can be increased 9in. in diameter by using walls 4½in. less in thickness.

The degree to which the cast house should be enclosed is dependent upon the climate. The South African conditions demand only a form of shelter, but this is elaborated at Dagenham by partly enclosing the sides with glazing. Neither approaches the totally enclosed cast houses found in some American plants.

At both Dagenham and Pretoria dry-quenched coke will be used, and this, after thorough screening, is conveyed to the furnace bins by belt, so no further extraction of breeze should be necessary. The absence of moisture renders it advantageous to charge the coke by weight; this is automatically carried out by weigh hoppers discharging into the skip tubs.

At both the plants stoves on the Schiffer-Strack system have been adopted. The checkerwork is scientifically designed and provides an exceedingly large area of effective heating surface.

The Dagenham stoves, three in number, measure 100ft. by 20ft., and the Pretoria stoves 105ft. by 21ft. Both sets have heating surfaces of 140,000 square feet per stove.

### GAS CLEANING.

The four gas uptakes at the furnace tops rise to a considerable height above the platforms before the connections to the downcomers are taken off. Two uptakes have sealed tops and two are surmounted by explosion valves designed to minimise the possibilities of ejecting solid material. The downcomers lead to plain expansion chamber dust catchers. At Pretoria the dust catcher is symmetrically placed on the side opposite to the skip bridge; at Dagenham demands of space have placed the dust catcher alongside the stove platform.

At Pretoria the gas passes from the dust catcher to a Lodge-Cottrell electrostatic dust precipitation plant of the two-stage type. The gases, after a preliminary cooling, are passed through an electrical precipitator where over 96 per cent. of the dust is recovered in a dry condition. They are then cooled down to approximately atmospheric temperature, and subjected, in a smaller installation, to a second electrical treatment from which they emerge with a dust content of less than 0·007 grain per cubic foot and free from all entrained moisture.

At Dagenham the gas is wet cleaned. It passes from the dust catcher through a Freyn pre-cooler, where, under sprays, the temperature is reduced to nearly that of the cooling water and where much of the heavier dust is extracted. Thence, through a manifold and three water seals, the gas enters the Theisen disintegrators, two of which are normally in operation with a third as spare. The disintegrators are of the non-pressure type with a capacity of 30,000 cubic feet per minute each, and the dust content is reduced to 0·01 grain per cubic foot.

The examination of raw material supplies disclosed the fact that it would be advantageous at Dagenham to install a fairly large sinter plant. This consists of a Dwight-Lloyd machine with an effective grate length of 51ft. and 72in. in width, the capacity being approximately 750 tons per day.

The pursuit of modern economical methods that has governed the selection of other auxiliaries is reflected in the equipment for handling the products of these furnaces. Pollock type slag ladles are used at both furnaces, their capacities being 330 cubic feet at Dagenham and 200 cubic feet at Pretoria, the latter being somewhat restricted by the narrow gauge of the railways. These ladles, by reason of their conical shape, give exceptionally easy discharge of the slag skull.

At Dagenham the hot metal has only a short haul of some 160 yards to the mixers or pig casting machine. It is conveyed in 75-ton open short-pour Pollock ladles of extremely heavy construction. These ladles are handled by overhead cranes in the hot metal building and the brief period for which the iron is in the ladle renders any heat-retaining features unnecessary.

At Pretoria the distance to the smelting shop is considerable, so 50-ton, heat-retaining, cylindrical ladles, by Demag, are used.

Both plants are installing Pittsburg pig casting machines, over which is poured week-end and surplus iron. The Dagenham machine is of the two-strand type, capable of handling 2 tons of iron per minute. A similar pig machine is being erected at Pretoria, but only a single strand is to be installed for the first campaign of the single furnace.

No sand beds will be required, cleaner pig can be obtained, and so much furnace labour can be dispensed with.

Mr. K. R. Binks opened the discussion by referring

to the statement in the paper that week-end iron is to be poured on the pig casting machine at Dagenham, and also to the fact that three hot metal mixers are installed there. The usual procedure where adequate insulated mixers existed was, he said, to store week-end iron in the liquid condition. What were the technical objections to that procedure at Dagenham? As regarded foundations, it appeared that under the conditions at Dagenham the Continental method of supporting the furnace top and skip incline on independent structures would offer increased stability. No provision seemed to be made for rail-borne ore traffic, and that precluded the use, in part, of, say, Oxfordshire or Leicestershire ironstone when adjustments were required in the phosphorus content of the pig iron, and restricted the flexibility of the furnace practice.

Mr. Fred Clements remarked that the conditions under which the plant at Dagenham was to work were largely American. The ore was imported from Newfoundland and Africa, and was treated very thoroughly because the conditions demanded a regular quality of iron. It would be quite possible to install similar plants in this country under similar conditions, but that was not entirely the real problem of the British iron and steel industry. We were being urged to develop home resources, and perhaps it was not fully realised that there were between 3000 and 4000 million tons of iron ores still in this country. At the same time, although Nature had been good as regards quantity, she had not been quite so good in quality, and we were faced with the task of producing pig iron economically from relatively low-grade material. That was one of the reasons why the fuel consumption in this country appeared to be very much higher than it was abroad. If we were to produce iron from a burden containing 30 to 32 per cent. of iron ore, as compared with American ore containing 48 to 50 per cent., surely it was obvious where the main difference lay. Nevertheless, we had been producing in this country for a long time pig iron from those ores at a cost of production which compared favourably with those of any country in the world, except India, and that was not often appreciated. It was said that the British iron and steel industry was inefficient, incapable, and rather unscientific. He took exception to that, but there was always room for something better, and if Major Brown and his associates would tackle the problem of increasing the use of our native ores, it would take us a big step forward. The problem, however, was not without difficulties. On an ore containing 50 to 55 per cent. of iron, one could afford to spend money, because, assuming that 2 tons of ore produced 1 ton of pig iron, it was economical to spend 1s. per ton on its preparation, *i.e.*, 2s. per ton of pig iron. With ore containing only 30 per cent. of iron, however, an equivalent expenditure would mean 3s. per ton. The main purpose of his remarks, however, was to try and indicate that this country was not entirely behind in the race in this question of the production of pig iron, and, further, that the mechanisation of any plant must have due relation to all the circumstances of the particular case. With our smaller furnaces, with perhaps apparently inefficient methods, we had been able to face the period of depression through which we had passed better than if we had been handling furnaces capable of huge outputs on a completely mechanised plan, although that might come in the future. Our position was the outcome of circumstances, and what the future held remained to be seen. Everybody looked with great interest to the actual results from Dagenham in the hope that they would assist the author and his associates in tackling the still bigger problem which remained. The industry in this country appreciated the need for still further progress, and he personally felt convinced that the era in front of us would be one in which the pig iron industry, and indeed the steel industry, would move to a period of unparalleled prosperity.

Mr. J. H. Harrison remarked that Fords were not amateurs in connection with blast-furnace works, and they would not have gone to the expense involved at Dagenham if they had not been quite sure of the results they would get. The great bulk of blast-furnace plants in this country were out of date, although we did not like to admit it, and could never hope to compete with such a furnace as that described. It was output that paid every time, and the larger the output the more opportunity there was of making the material at a cheaper rate. The plant at Dagenham was a model on which we should have to rebuild the existing plants in this country before we should be able to regain and maintain the position we had always held. The type of plant was not new, but had been fully demonstrated in America and Germany, and also in the Dominions, so that we would not be making experiments here in following what had been done at Dagenham. The trouble was that we had no money to do it, but if the industry did not sit still, but made a move to do something to reduce the cost of pig iron, the Government would not see the industry go right out. The country could not do without an iron and steel industry, and if the Government would not voluntarily help the industry, then the country must force the Government to do it.

Mr. A. Hutchinson said the paper showed in a remarkable manner what could be done when one came to install blast-furnace plants on green fields, provided ores similar to those which were to be used at Dagenham were utilised. Unfortunately, however, all manufacturers were not in that happy position, but had to work with ores available in this country, and undoubtedly British ironmasters had done that very efficiently hitherto. It became a serious question as to whether it would pay economically to scrap existing plants and build others along the lines described. It could be said that those responsible for the industry in this country had diligently looked into that question, and the fact that plants continued to be worked under much the same conditions as those of thirty years ago, was because under the conditions prevailing, it was impossible to see a return on the capital if a wholesale scrapping took place. Mr. Ford was a very wealthy man, and had a marvellous plant at Dagenham, but it was doubtful whether the finished product would be turned out as cheaply as it was in some of the American works. Nevertheless, he was to be thanked for the effort he had made in Great Britain.

Mr. Benjamin Talbot pointed out that there seemed to be no room for a second furnace at Dagenham, but provision for building one appeared to be necessary, for experience showed that the harder a furnace was driven, the shorter its life. It was quite true that there were vast quantities of iron ore in the Midland Counties, but with to-day's method of mining much of that ore was not commercial. The question was whether it could be converted into a richer condition, and it was only if that could be done that existing works could expect to reach the large output of the Dagenham plant. With the American ores, it was possible to make 1000 tons per day plants commercial, but it would not be possible with our ores to operate such furnaces economically in this country. The technical problem, of course, was solved, but with 1000 tons per day furnaces the enormous capital value, as compared with that of a 500 tons plant, was an important factor.

Monsieur F. Clerf emphasised the point that the preparation of raw materials is the most important point in operating blast-furnaces, and that the cost of making pig iron is very low compared with the cost of raw materials. With a large furnace the most important thing was to keep the fuel consumption at the lowest point. Most of the furnaces on the Continent manufactured pig iron at a cost less than the cost of raw materials, because of the large return from the gas and the very low cost of labour.

Mr. T. Hoskison said that whilst everyone must be impressed with the Dagenham plant as an engineering proposition, it must be remembered that it was not a commercial plant in the ordinary sense of the word, because it was not producing material in competition with other manufacturers, but was producing a material for the purposes of the firm, which was worth twice the value of the ordinary foundry or basic pig iron. For that reason the plant justified the heavy capital charges. Before, however, the plant could be fully criticised, it was only fair to wait until it had been in operation for a suitable period.

Major Brown, replying to the discussion, said the conditions as regards week-end iron at Dagenham were very different from those in the ordinary foundry, and without disclosing the intentions of the firm or committing it in any way, he could say that the intention was to make cold pig for the Cork tractor factory, and no more suitable days could be taken for sending the cold pig to Cork than the week-end. That explained the use of the term "week-end iron" for the pig casting machine. With regard to rail-borne ore, the resources that were available for the plant had been thoroughly investigated, and it had been decided that for the particular kind of iron required it was essential to bring in ores from the Dominions and abroad, and that eliminated any necessity for a material-handling section from the railways. At the same time, it would be quite possible to make such a connection without any serious alterations. It was to be hoped that those who were responsible for the iron industry in this country would take full cognisance of what Mr. Clements had said. The object of the paper was to point out that each and every plant must be designed for the existing conditions and circumstances, but he hoped that would not preclude an opportunity some day of trying his hand on a plant dealing with home ores. Indeed, he rather imagined that home ores gave a larger scope, because one of the great features of mechanical blast-furnaces and the high-duty equipment that went with them was the saving to be made in handling large tonnages, and blast-furnaces working on home ores handled a very much larger tonnage than a blast-furnace working on imported ores. He suggested that the handling of large tonnages of raw material was probably the most promising sphere in which savings could be made in this country. Those responsible for making a success of the industry must first decide what the output should be, and then call in the help of the engineer to attain that output. Those who had built the plant at Dagenham would be the last to advocate a wholesale scrapping of existing plants, or to suggest that the new plant, if erected elsewhere, would cure all ills. As Mr. Hutchinson had said, the capital return must be considered, but when security returned to the iron industry he believed the people controlling it would not be slow to act. In reply to Mr. Talbot he said there was room provided for a second furnace at Dagenham. He strongly opposed the suggestion made by Mr. Hoskison that the plant at Dagenham was not commercial. Some very shrewd heads had the decisions to make, and the cost of the iron was so carefully analysed that it did not vary very much from the cost of ordinary foundry iron. Moreover, the iron was certainly nothing like twice the price of foundry iron.

A paper describing recent improvements in the Greenawalt sintering apparatus was presented by J. Tornblad and briefly discussed.

It was followed by one by Dr. Ing. A. Fry on "The Theory and Practice of Nitrogen Case Hardening," which is sufficiently described by its title. In the discussion Dr. W. H. Hatfield said that whilst the author's explanation of the hardness introduced by the nitriding process based on the slip interference theory might be justified on general theoretical grounds, it was, nevertheless, pure speculation. A great deal of work was being done both in America and in this country with the object of increasing the thickness of the case and reducing the time of the operation; but it could not be said that much had been achieved in that direction yet from the industrial point of view. With regard to the interesting further advance made in which the author produced a steel in which the core would, by precipitation, reinforce the hardened surface, he would like to know about the volume changes as between the core and the outer skin. Had the author gone far enough in the matter to make it clear that a core of such a nature produced by such a process would not tend to rupture the case?

Mr. B. Jones said he had carried out an investigation during the past year on the effect of the constituent elements on the nitriding properties of chrome-aluminium manganese steel and the results, which would shortly be published, were not incompatible with some of the explanations put forward by the author.

Dr. W. Rosenhain, referring to the effect of the hardened skin in increasing the resistance of steel to alternating stresses, as mentioned in the paper, remarked that the results given were obtained from alternating bending tests made presumably by the Wohler or similar process. In those circumstances the highest stress was developed in the skin, and if in such a material a hardened skin was produced, then the fatigue resistance to alternating bending was increased very materially. If the results of fatigue tests obtained under bending were applied to the case of a piston in which the stresses were essentially push and pull, the results would be disappointing to the author, because there was not in that case the corresponding increase. The effect of corrosion fatigue was very important, and it opened possibilities of uses for nitrided steel which, at first sight, might not be very obvious. When it was realised how widespread corrosion fatigue was it was evident that there were many places where a material free from it could be used to very great advantage. Corrosion fatigue was due, not only to water, but also to air, whilst air dissolved in or entangled with oil could have a similar action under certain conditions. A good many of the mysterious failures of aero-engine crank shafts might probably be traced to actions of that kind. Great, however, as were the advantages of nitrided steel, there was one trouble, and that was the fragility of the surface, with the result that in cases where shock occurred the material was not sufficiently resistant to be employed with complete confidence. What was wanted was perhaps not quite so high a degree of Brinell hardness, but a greater degree of toughness. Dr. Rosenhain then discussed the theory put forward by the author.

Dr. N. P. Inglis said that there were two disadvantages of the nitrogen process, namely, the increased time and the necessity for using special steel. The latter was one which could not be removed; undoubtedly a special material was required and therefore in order to improve the prospects of competition with other forms of case hardening attempts at accelerating the process seemed to offer the most fruitful field.

Dr. Ing. Fry, replying partly to the discussion, said certain experiments on the volume changes referred to by Dr. Hatfield had been made, but they were still in course of progress. It could, however, be said that the change in volume by precipitation hardening must be recognised, but it was not so great that there would be any danger to the nitrided skin. With regard to the fragility of the surface, he said it was possible to make some types of steel in which the hardness on the outer layer was obtained at a temperature of not more than 800 deg. or 900 deg., and in that case the material would be less fragile than when a temperature of 1000 deg. or 1100 deg. was employed.

A paper by Sir Harold Carpenter, F.R.S., and Mr. J. M. Robertson, on "The Austenite $\rightleftarrows$ Pearlite Inversion," was then read. It is a continuation of a prior paper which dealt with the structural aspects of the formation of ferrite from austenite and is concerned with the reverse change on heating. It will be followed by another paper describing the effect of time and the temperature of heating on the structures obtained on cooling. The discussion was carried on by Dr. W. H. Hatfield, Professor C. H. Desch, Colonel N. T. Belaiew, Mr. T. H. Turner, and Mr. R. S. Brown.

Mr. J. E. Hurst then presented a paper entitled "Some Experiments on the Nitrogen-hardening of

Cast Iron," upon which there was no discussion.

Consideration was next given to a paper by Mr. L. W. Schuster, on "The Influence of the More Common Elements in Inhibiting Needles in Nitrogen-rich Steels and Arc Welds."*

NEEDLES IN NITROGEN-RICH STEELS AND ARC WELDS.

The present paper is a sequel to a previous one, which showed that the various structures obtainable in Armco iron welds were identical with those obtained in nitrogenised Armco iron; results were also given of welds made in nitrogen and other gases, where nitrogen alone formed needles and braunite. As in all later experiments needles have never been found in welds in the absence of nitrogen, their presence in welds is in this paper considered to be caused by nitrogen only.

The investigation was carried out mainly to ascertain the alteration to the structure of hypo-eutectoid steel containing nitrogen, caused when the more common constituents were added in quantity. The information was particularly required for arc welds so that from microscopic examination alone it might be possible to determine, within limits, the extent to which a weld had been contaminated by the atmosphere—the more so as it is not unusual to find that welds are highly contaminated, though under the microscope they appear to be made of high-class metal containing pearlite, no nitride needles or other sign of contamination being distinguishable. Such welds may easily deceive the observer, for they may actually contain a high percentage of nitrogen, which can often be made to assume the particularly objectionable needle form.

Mr. E. W. Colbeck said he had some difficulty in understanding some of the results with regard to the influence of manganese. Tables I. and II. showed some surprising discrepancies between covered and uncovered electrodes. The loss of manganese was very much greater in the case of the uncovered electrodes, but whether that was due to slagging off and the formation of manganese silicate or not, he did not know. These results appeared to require some explanation. He had looked up a few results obtained in the I.C.I. laboratories on brittle bolts, which were found, on analysis, to contain nitrogen, and the figures suggested that with increasing nitrogen content, other things being equal, the impact strength fell off very considerably. There should, however, be the warning that it probably depended upon the amount of nitrogen out of solution. The results given in the paper as to the effect of chromium in inhibiting needles was particularly interesting in regard to austenitic stainless steel, the weld of which showed the formation of brittle membranes at the grain boundaries which the author concluded were nitrogen rich. Personally, however, he thought it more probable that nearly all nickel-chrome steels of the austenitic class contained rather more nitrogen than most people gave them credit for.

Dr. Ing. A. Fry said the German technical authorities had for a long time opposed the introduction of welding into boiler practice on the ground that welding was not reliable enough and to a certain extent he felt they were right. A fortnight ago he had the opportunity of listening to a lecture in the Technical High School at Berlin by Director Potts, who had studied the influence of nitrogen in the weld and also the effects when nitrogen was kept out of the weld. Nitrogen was kept out by use of a special kind of covered electrode, and it was found that those welds which contained a large amount of nitrogen were in all cases improved by annealing. With electrical welding, on the other hand, which contained nitrogen, the welds were worse after annealing.

Mr. A. T. Roberts said the impression had been gained that nitrogen was a harmful property in welding, but that was not so. In most commercial steel welds carbon and manganese were both below 0·1 per cent., or 0·1 per cent. as a maximum, and in some tensile tests which he had made recently a figure of 30 tons was obtained in one case with 28 per cent. elongation, whilst in another the figure was 27 tons tensile and 27 per cent. elongation. In the first case the manganese was 0·33 and the carbon 0·09, whilst in the other the manganese and carbon were both 0·1 maximum. It would have been impossible to obtain these figures had there not been some hardening element present having an effect similar to that of carbon. Work had been done showing that nitrogen had an effect on steel similar to that of carbon, but to a much greater degree weight for weight. The chief aim in the deposition of weld metal should be not to exclude nitrogen entirely, but to regulate the amount.

Dr. N. P. Inglis asked for complete details of the nitrogen method of analysis adopted by the author. Also whether the nitrogen content given in the paper was the total nitrogen, *i.e.*, the occluded nitrogen and the combined nitrogen. It was the latter which was the most important.

Mr. D. Sillars asked for information with regard to annealing welds, adding that in some experiments he had carried out annealing had not been very satisfactory. He also inquired what means the author adopted for determining the success of his weld. It rather appeared that the extent to which needles did or did not exist determined, in the author's mind, the success of the weld, but it would be necessary to have something more specific and accurate in order to convince an engineer on that point. His own experience with many tests was that whether dealing with covered or uncovered electrodes the weld was worse after normalising than before normalising.

Mr. Schuster, in his reply to the discussion, said that the question of whether nitrogen was harmful in weld metal or not, depended on the degree to which it was present, and there was nothing in the paper suggesting that nitrogen was harmful or otherwise. It was certain that there were other elements in the weld metal far more harmful than nitrogen, and one of them was oxygen. There was a great deal of truth in what Mr. Sillars had said with regard to the annealing of welds and the effect on shock tests. His experience had been that the annealing of welds very often brought down the shock value, but in other cases using a very good braunite form of annealing he had found that the shock test had actually gone up.

The final paper on Thursday, May 5th, was one by Messrs. A. J. Bradley and A. H. Gay, on "The Lattice Spacings of Iron-aluminium Alloys."

* See also a long illustrated paper, under the same title and doubtless by the same author, in the Technical Report for 1930–31 of the British Engine, Boiler and Electrical Insurance Company, Ltd.

### Annual Dinner.

The annual dinner was held at the Connaught Rooms on Thursday, May 5th, under the chairmanship of the President, Sir Charles Wright. Proposing the toast of "The Iron and Steel Industries," General Sir Herbert Lawrence referred to the measure of protection which the Government had accorded the industry in its home market. That protection, he said, might not be as complete as some desired, but it at least put a weapon wherewith to bargain in their hands. He was strongly of opinion that the world would be better with Free Trade, but not with a one-sided Free Trade, such as we had known. He urged that we should concentrate on the maintenance of our home market and on drawing closer the bonds which united us to other parts of the Empire. Mr. John Hodge, the veteran leader of the iron and steel workers, replied, and revealed himself as a staunch and life-long supporter of the policy of Protection. Sir Harold Carpenter proposed the toast of "The Guests," to which Field Marshal Sir George Milne responded. The evening ended with the toast of "The Institute," submitted by Sir John Cadman, and the President's response.

*(To be continued.)*

## Electric Boilers.

At a recent meeting of the Toronto Branch of the American Society of Mechanical Engineers, Mr. B. A. Malkin, chief engineer of the paper machinery department of the Dominion Engineering Works, Ltd., Montreal, read a paper on "The Generation of Steam from Electricity." The present period of depression, it seems, has led to greatly increased interest in this matter on the part of electricity supply undertakings, which now have a surplus of generating plant. Hydro-electric development has more than kept pace with industry, as most of the supply companies have provided for industrial expansion, but as the result of poor trade, much plant is idle. The interest that has been aroused in the generation of steam from electricity is a repetition of what occurred in 1921–22, when apparatus for the purpose was first introduced into Canada by Mr. F. T. Kaelin, of the Shawinigan Water and Power Company, who conducted a large number of experiments pertaining, among other things, to the specific resistance of water at various temperatures and concentrations. But long before the introduction of electric boilers into Canada, they were in use elsewhere, notably in Switzerland and Sweden, some of these installations being nearly thirty years old. The best known of these boilers is the "Revel," made by Escher, Wyss and Co. Originally built in capacities up to 2000 kW, it is very similar to boilers of the water resistance type made at the present time.

When the Shawinigan Water and Power Company began to investigate the possibilities of these boilers, Mr. Kaelin introduced several improvements, and evolved the three-tank type of generator, which made possible the high voltages and capacities in vogue to-day. Voltages up to 13,000 are now in use, and single-unit boilers with capacities of 42,000 kW are in successful service. The development and use of large electric boilers is a Canadian achievement. Their design is the work of Canadian companies, and no other country uses large electric boilers so extensively.

For high voltages and large capacities, the water resistance type of boiler is the only one practicable. In this type, electrodes are submerged in water, as shown in Fig. 1, and the heat is generated by the passage of the current through the water, which forms a resistance. Alternating current is alone suitable for the purpose, as D.C. would decompose the water. Boilers having resistors enclosed in tubes are only suitable for relatively low voltages and capacities, and the control is rather complicated, as the steam production is regulated by switching the parallel circuits in which the resistors are arranged on and off, according to requirements. Steam generators of this type are large for their output, and consequently expensive, but they offer the advantage that they can be worked with either A.C. or D.C.

Water resistance boilers are being built in Canada by two companies—the Dominion Engineering Works and the Canadian General Electric Company. The former concern took up the manufacture of the Kaelin electric boiler late in 1921, and the first boilers were completed in April, 1922. They were built to the order of the Shawinigan Water and Power Company, and were installed in the mill of the Lawrentide Paper Company at Grand Mere. There are two three-phase units, each of 25,000 kW capacity, and designed for a pressure of 6600 volts. All the valves and controls are centralised and operated by one man. Since these boilers were installed, the company has built or has under construction ninety-three units, with an aggregate capacity of 910,000 kW. The voltages of these boilers range from 550 to 13,200, and the largest capacity is 42,000 kW.

In 1924 the Canadian General Electric Company introduced a boiler incorporating novel features, and it has now installed thirty-seven units, with an aggregate capacity of 190,000 kW, making a total of over 1,100,000 kW for the two companies. The Canadian General Electric Company's boilers have been built in capacities up to 20,000 kW and for pressures up to 12,000 volts.

Of the boilers built by these two concerns, Mr. Kaelin's is the simplest, although the main features of the General Electric boiler are very similar to those of the Kaelin single-tank unit. Three-tank and single-tank Kaelin boilers are made. The first consists of three pressure vessels, each having an electrode connected to one phase of a three-phase supply. Each tank has a protector plate, which prevents damage to

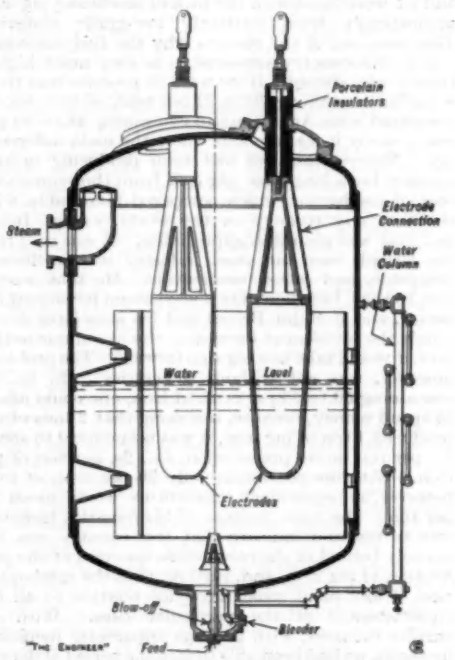



FIG. 1—WATER RESISTANCE ELECTRIC BOILER

the shell, and the three plates are connected together to form the neutral point, which is earthed. On the steam side the three tanks are connected together, but each tank has independent feed and "bleed" control valves, in order to prevent surging and consequent unbalancing of the three phases. In the case of the single-tank boiler, all the electrodes are contained in the single pressure vessel. Part of the current flows from electrode to neutral and neutral to electrode, whilst the remainder flows between electrodes, thus forming a combined star and delta connection. Generally speaking, the three-tank type is used for the higher voltages, and the single-tank type for the lower voltages. Two years ago no single-tank unit had been built for a pressure higher than 4400 volts, but since that time a 6600-volt unit has been developed and several are now in operation with capacities up to 25,000 kW.

The boiler built by the Canadian General Electric Company is a single-tank unit. The essential difference between it and the Kaelin boiler is that it is divided into two compartments, as shown in Fig. 2. Steam is generated in the upper compartment, and the generation is controlled, as in the Kaelin boiler, by the amount of the immersion of the electrodes. Water is circulated between the two compartments by means of a centrifugal pump and is drained from the upper chamber or "basket" to the lower storage chamber through external piping and a control valve. A throttle valve on the pump discharge pipe regulates the flow, the water level in the basket and consequently the rate of steam generation. The advantages of the design are that the lower chamber forms a reserve of hot water which enables the boiler to respond more quickly to increased steam demand. As the control is centred in one valve, automatic regulation is a simple matter.

The quantity of steam produced by an electric steam generator of the water resistance type depends upon the amount of current passing through the water, and this, in turn, depends on the area of the path and the specific resistance of the water. The first is approximately proportional to the depth of immer-

sion of the electrodes, so that if a constant specific resistance of the water is maintained, the amount of steam generated is controlled by the level of the water in the boiler. The specific resistance of the water is a function of the amount of dissolved solids, and of its temperature, and in order to maintain a constant specific resistance it is necessary to allow water to escape from the boiler. A certain amount of dissolved solid matter enters the boiler in the feed, and as no solids can be carried off with the steam, water must be bled from the boiler, for otherwise the concentration of the water would continually increase, and its resistance would decrease.

The most important matter to be kept in view in connection with the operation of an electric steam generator is that the current density on the electrodes must be maintained at a low value by keeping the water level as high as possible. If the current density is too high, it causes decomposition of the water by local arcing and rapid wear of the electrodes occurs. Corrosion of pipes and other parts of the steam system is also experienced, owing to the generation of gas. Investigations as to the cause of the excessive production of gas, apart from high current density, have so far been inclusive. But apparently there has only been one installation in Canada which has given

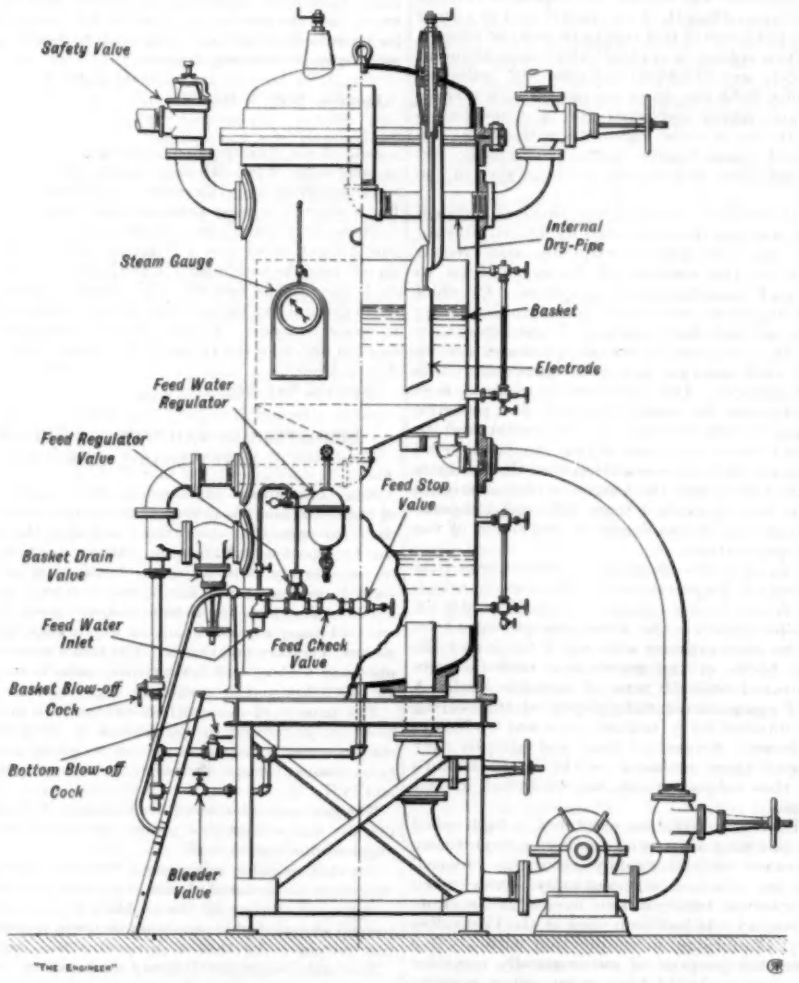



FIG. 2—SINGLE-TANK, TWO-COMPARTMENT ELECTRIC BOILER

serious trouble in this respect. The electric boilers of this installation are still in use, and the generation of gas has been greatly reduced by regular cleaning and removal of electrode scale, which, by blocking the path of the current, causes local points of high current density. Usually the "bleed" water is much more concentrated than the feed, and the proportion of the "bleed" depends entirely on the quality of the feed. With very pure feed water, the usual periodical blow downs suffice.

As most of the heat escaping with the "bleed" is wasted, the amount of the "bleed" has a considerable influence on the efficiency of the boiler, but if the feed water is of good quality, efficiencies approaching 100 per cent. are said to be obtainable. Owing to the comparatively small disengaging area, electrically generated steam has a greater moisture content than usual, but it can be reduced to less than 1 per cent. by the use of a suitable steam dryer. As no part of an electric steam generator is exposed to a higher temperature than that of the steam, and as there is no risk of explosion owing to low water level, they are exceptionally safe.

Most of the large electric boilers in Canada work in parallel with coal-fired boilers and are manually operated, as the law demands the presence of an engineer. Many small heating boilers are, however, automatically controlled in accordance with the steam pressure. In the simplest case the generator is fed from a cistern placed at a height corresponding to the working pressure. In the case of larger units and those designed for higher pressures, pressure control valves on the steam line operate the feed and bleed valves. The original Revel boiler had a spring or weight-loaded relief valve on the "bleed" steam line and was set to open at a pressure slightly below that of the safety valve. Thus if the boiler was generating an excess quantity of steam water was discharged, thereby lowering the level and automatically reducing the amount of steam generated. While a number of the smaller Kaelin boilers are regulated in this way, the scheme is not applicable to electric steam generators working in parallel with other boilers.

Controls have been developed which are practically automatic on the electrical side and can be arranged so that the generator receives constant power or the surplus power available at any time. These controls, however, fail to be entirely automatic, in that they do not regulate the water concentration, and while they may give fairly good results with feed water of good quality, if the water is impure considerable attention is necessary in order to avoid trouble. But an automatic control system has recently been developed in which constant water level is maintained by a water level regulator operating the feed valve. The "bleed" valve is operated by the steam pressure, thus regulating the water concentration in the boiler in accordance with the steam demand. In this way the inventor claims to be able to take care of 50 per cent. load variation. For greater variations two regulators are required on the feed line. This form of control has been developed so as to make it applicable to a three-tank unit. One tank on one phase is controlled as described, while the other two phases are dealt with by current balance relays which keep the phases in balance. A three-tank electric steam generator rated at 35,000 kW that is being installed will be controlled in this way, and the results are awaited with interest.

The electric steam generator has several advantages which should in some cases offset the relatively high cost of working it, *i.e.*, low first cost, cleanliness, small space required, and no coal storage or ash disposal problems. It can be started up quickly and shut down instantly. Generally speaking, however, the use of electric power which could be used for any purpose other than that of raising steam is commercially impracticable. Employed for the utilisation of surplus power, the electric boiler is claimed to be capable of bringing about large savings to industrial concerns and of providing a source of considerable revenue to power companies. The surplus power may be seasonal or week-end excess power, or it may become available as the result of industrial depression or too rapid hydro-electric expansion.

A scheme has been devised whereby the companies sell steam to the consumer. In some cases the company owns the boiler and contracts with the consumer to operate it and use such power as is from time to time available for generating steam. The companies reserve the right to withdraw the power at any time, provided they give the consumers sufficient notice to bring the steam-fired plant into operation. But so far this method of disposing of surplus power has only been exploited to any appreciable extent in the province of Quebec, where one of the companies has boilers of 334,000 kW capacity on its mains. At present the largest users of electric boilers are the paper mills, which employ 87 per cent. of the total installed boiler capacity. Many large industrial establishments, however, use large quantities of steam, and where a power company has surplus plant the electric boiler has a possible field of application. Of the electric steam generators in operation in Canada, 82 per cent. of the total capacity is in the province of Quebec, where the power companies have made special efforts to secure a steam-raising load. On the Shawinigan Water and Power Company's mains there are twenty-four installations with a total capacity of 334,800 kW, whilst on the mains of the Montreal Light, Heat and Power Company, which purchases power from the Shawinigan Company, there are boilers with a total capacity of 27,000 kW. The general distribution of the boilers is as follows :—

| | | | |
|---|---|---|---|
| Quebec | 58 boilers, | representing | 808,150 kW |
| Ontario | 24 ,, | ,, | 174,450 ,, |
| Manitoba | 33 ,, | ,, | 64,600 ,, |
| British Columbia | 7 ,, | ,, | 20,570 ,, |
| Other parts | 4 ,, | ,, | 38,000 ,, |

The total capacity of these 126 steam generators is 1,105,770. The figure of 808,150 for Quebec represents 26 per cent. of the total hydro-electric installed capacity in that province, and the 174,450 kW for Ontario 7½ per cent. of the installed capacity. These figures do not include boilers of less than 5 kW capacity, many of which have been installed in laundries and in office buildings and houses for heating purposes. Where fuel-fired boilers are not operated in parallel with electric boilers it has been deemed to be necessary, up to the present, to provide a steam accumulator to take care of variations in steam demand in paper mills. As the electric boiler has a relatively small volume of water and very little reserve steam capacity, it has been deemed to be incapable of responding to a sudden large increase of load, but two Kaelin boilers now being installed are designed to pick up the load rapidly without the help of accumulators.

Two examples of electric boiler installations are shown in Figs. 3 and 4 on page 530. The two three-tank units shown in Fig. 3 each have a capacity of 32,000 kW at 13,200 volts. They are installed in the paper mill of Price Bros. and Co., Ltd., at Riverbend, Quebec, and provide the entire steam demand of the mill. The other installation shows three 42,000-kW and one 21,000-kW three-tank electrode boilers in the Canadian International Paper Company's mill at Gatineau, Quebec.

## THE INSTITUTE OF TRANSPORT.

THE Congress arranged by the Institute of Transport will be held at Buxton from Wednesday, June 1st, to Saturday, June 4th, 1932. On Wednesday, June 1st, the Congress will be opened by the President at the Palace Hotel, Buxton, at 9.45 a.m. His Worship the Mayor of Buxton will welcome the delegates to the Congress. Papers will be read on "Rationalisation on the London, Midland and Scottish Railway," by Mr. E. J. H. Lemon; and "Scientific Research on the London, Midland and Scottish Railway," by Sir Harold Hartley, F.R.S. On Thursday, at 10 a.m., a paper on "Fuel Research in Relation to Transport" will be read by Professor R. V. Wheeler; and the concluding paper on "Public Service Motor Transport—some International Comparisons," by Mr. Horace M. Wyatt, will be read at 10 a.m. on Friday morning. The following visits and excursions have been arranged :—Wednesday afternoon, the control office of the London, Midland and Scottish Railway at Derby (limited to twelve persons); the works of the London, Midland and Scottish Railway at Derby; and the works of Rolls-Royce, Ltd., at Derby.

On Thursday morning the ladies will visit the Buxton Pavilion Gardens. The afternoon will be devoted to a visit to Chatsworth. Ladies will visit the Buxton Baths on Friday morning. Afternoon visits will be made to the works of the North-Western Road Car Company, Ltd., at Stockport, and the Hyde-road Depôt of the Manchester Corporation Transport Department, the Manchester School of Signalling and the colour light signalling installation of the London, Midland and Scottish Railway at Manchester.

On Saturday morning the Buxton Coal Mine Experimental Station will be visited, also a whole-day visit has been arranged to the Manchester Ship Canal.

On Wednesday, June 1st, the Mayor and Mayoress of Buxton will hold a reception and dance from 8.30 p.m. to 12 p.m. On Thursday evening, at 8.15 p.m., there will be a concert in the Pavilion, and on Friday evening the President, Mr. Frank Pick, will hold a reception and dance from 9 p.m. to midnight.

IN replying to the discussion on the vote for the Ministry of Transport on May 6th, Mr. Pybus said that negotiations with regard to the London Traffic Bill were proceeding, in his opinion, satisfactorily, and he hoped before long to be able to acquaint the House one way or the other as to how the Bill stood.

## The Royal Society's Conversazione.

THE exhibits shown at the Royal Society's Conversazione, held at Burlington House, London, on Wednesday evening of this week, covered, as usual, a very wide range of scientific interest. While there were many of a physical nature, there were few or none which might be described as being primarily of an engineering character.

Mr. George H. Gabb, as on many previous occasions, had an item of historical interest to show us, a faithful reproduction of Robert Hooke's hygroscope, which was the first attempt to construct an instrument to show "the driness and moisture of ambient air." Mr. Gabb constructed the instrument exhibited from the description and illustration of it given in Hooke's "Micrographia," which was published in 1665, and which was the first book issued under the Royal Society's licence. The operating element of the instrument was the beard of a wild oat, the structure and reaction to moisture of which were studied by Hooke. The beard is in the form of a stranded cable, which coils and uncoils with variation in its state of moistness. A similar provision is made by Nature in other instances, and is designed to give the seed to which the beard is attached a propeller-like action, whereby it bores itself into the ground, and thereby escapes the attention of birds. An excellent slow-motion cinematographic representation of the action was included, it may be remarked, in one of the films shown at the soirée of the Institution of Mechanical Engineers last Friday evening. Hooke, and Mr. Gabb after him, employed a piece of the wild oat beard about an inch long, and attached it vertically beneath an index or hand, which was mounted to rotate across a horizontal dial. With a considerable variation in the moisture of the air, the hand may make as many as three or four complete turns under the winding or unwinding action of the beard.

Dr. L. J. Spencer, of the British Museum, had an interesting display of meteorites collected last year from thirteen craters near Henbury, in the very centre of Australia. In all, 1350 pieces have been found. They range from a fraction of an ounce to 170¼ lb. in weight. They are all of the metallic variety, and, as usual, are composed predominantly of a nickel-iron alloy. It appears certain that they are the remains of a shower of meteorites, but there is nothing to indicate at what date they struck the earth. The natives, we were informed, have some tradition concerning the locality, and will not go near it.

Imperial Chemical Industries had several exhibits of apparatus and methods developed in the research laboratories at the company's Northwich Works. A film was shown illustrating the growth and allotropic transitions of crystals in solutions of ammonium chloride, sodium chlorate, and other compounds. By means of a particular system of illumination, the crystals were shown growing against a background of interference lines. Initially when the solution was of uniform concentration, the interference lines were everywhere parallel, but as the crystals began to grow the lines in their neighbourhood assumed a curved form, indicating the local decrease of concentration in the solution which accompanied the crystal growth. When the crystals approached the limit of their growth, the lines began to resume their initial parallelism. It is hoped by further study of the change of form of the lines to follow the local changes of concentration which occur in the solution in the neighbourhood of the growing crystals.

A second exhibit from the same source consisted of some spiral springs made of fine-drawn quartz thread. These springs, we learned, are made by a glass blower with the aid of a blow lamp and a circular former. They have found a useful application in physical research. The rate at which bodies adsorb vapours can be determined by suspending the bodies from a fixed point by means of a quartz spring and observing the extension of the spring with time. The value of the quartz springs lies in the fact that they can be employed in atmospheres which would attack metal springs.

A third exhibit shown by the company was a pressure balance for the measurement of pressures from 300 to 2000 atmospheres. The device, developed by Dr. A. Michels, of Amsterdam University, makes use of a very accurately made differential piston loaded with known weights. The fluid pressure acts on the annulus of the differential piston, which annulus has an area of only one-tenth of a square centimetre. The piston is rotated by a power drive, which almost completely eliminates metallic contact between the piston and the cylinder walls. It is stated that the sensitivity of the device is such that by means of it changes of pressure as small as one part in 200,000 can be detected. In the company's research laboratories experiments have already been carried out with pressures as high as 3000 atmospheres, and it is hoped shortly to go to 10,000 atmospheres. At 2000 atmospheres benzene flashes off into the solid state. It is believed that it may be possible to employ high pressures for the purpose of separating the constituents of certain liquid mixtures.

Dr. G. D. West, of the Military College of Science, Woolwich, gave a demonstration of the forces acting on drops in an electric field. A square glass vessel was filled with distilled water in which were immersed two electrodes in the form of plates disposed on opposite vertical sides of the vessel. A drop of an electrolyte, such as permanganate of potash, or of the dye known as eosin, was allowed to fall through the water in the space between the electrodes. When a field of about 50 volts per centimetre was applied to the electrodes, the drop was seen to spread out into a horizontal filament parallel with the lines of force. It is suggested that the experiment may provide a means of detecting in transformer oils the presence of impurities that might lead to a breakdown.

Sir William Bragg demonstrated the optical phenomenon known as Bidwell's experiment. A red lamp was shown for a fraction of a second and then was hidden by an illuminated white screen. The green reaction was so strong that the red light on succeeding exposures was not seen at all.

Some curious phenomena associated with diamonds were shown by the Government Chemical Laboratory. It has recently been found that there are two types of diamond, one of which is transparent, while the other is opaque in certain regions of the infra-red and ultra-violet portions of the spectrum. The exhibit included a demonstration of the discovery that a diamond of the transparent type generates a current when it is exposed to ultra-violet light. One such diamond was shown developing a current of about one ten-millionth of an ampère and requiring an opposing potential of 0·6 volt to reduce the current to zero. When voltage is applied to the same diamond various effects are exhibited. Under the influence of ultra-violet light the diamond passed into a state of activation which persisted for a considerable time after the ultra-violet light was withdrawn. In the activated state visible light, particularly red light, had the effect of reducing the resistance of the diamond.

Among the exhibits shown by the National Physical Laboratory was one demonstrated by Dr. G. Shearer and two of his colleagues, illustrating some recent applications of the method of X-ray analysis to industrial and manufacturing processes. Of chief interest to engineers were some photographs giving the results of detailed studies of the successive effects on the structure of metals produced during progressive cold working and other processes, such as heat treatment. The photographs showed how the method could be used to detect the presence of distortion in the crystals of the metal and to measure its degree. It is, we gather, to be inferred from the results of the investigation that the hardness of a quenched steel and the magnetic characteristics of tungsten steel quenched from different temperatures are functions of the degree of distortion of the crystalline space lattice.

Another exhibit of radiographic interest was that of the Research Department at Woolwich, which showed an X-ray tube designed to operate at 400 kV and 20 milliampères. The tube was protected by encircling the glass cylinder with one of thick metallic lead. The backs of the anode and cathode were likewise covered with 10 mm. of metallic lead. A selection of comparative radiographs of engineering structures obtained by $\gamma$ (radium) rays and by X-rays was also shown. Several of these radiographs were identical with those included in Dr. V. E. Pullin's article on this subject which we published in last week's issue.

Dr. C. E. Wynn-Williams exhibited a high-speed automatic counting apparatus employing thyratrons. This apparatus enables rapidly recurring physical events to be counted automatically, even when the time interval between two events is as short as $^1/_{1250}$th second. It has been used at the Cavendish Laboratory, Cambridge, in conjunction with a valve amplifier for the purpose of automatically counting $\alpha$-particles, but it should have many other applications.

The Cambridge Instrument Company, Ltd., showed a smoke or dust recorder, in which the light diffracted by the suspended matter is arranged to fall on a photo-electric cell, the current from which, measured on a thread recorder, is taken as a measure of the smoke or dust density.

The Radio Research Station at Slough gave an elaborate demonstration of the use of the cathode ray oscillograph in radio research. Among the applications exhibited were the photography of atmospheric wave forms, direction finding, the location of thunderstorms, and the study of the ionisation in the upper atmosphere. A lecture on this subject was delivered during the course of the evening by Mr. R. A. Watson Watt.

Among other exhibitors were Adam Hilger, Ltd., who showed spectroscopic equipment, an X-ray metallograph and an instrument for effecting rapidly calculations connected with the separation of salts from solutions; Professor W. A. Bone, who exhibited records of gaseous explosion experiments; Mr. J. Harvey, of the City and Guilds Engineering College, who demonstrated a harmonic analyser, making use of scale pans and weight for measuring the twelve coefficients of a sine and cosine series; the Research Laboratories of the General Electric Company, apparatus for the generation and detection of ultra-short continuous electric waves, and Standard Telephones and Cables, Ltd., apparatus for determining the transmission condition of telegraph lines and equipment.

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### RAILWAY SPEEDS.

SIR,—I am obliged to "D. T. L." for the courteous way in which he has received my representations. What I really intended to point out was that the sensational acceleration of the 7.50 a.m. *ex* Leeds was wholly south of Retford, and that over the sections on whose difficulty he rightly commented, the booking remained unaltered. In his letter in your issue of 6th inst., the figure of "68·2" for the speed of the "Cheltenham Flier" from Swindon is evidently a misprint for "69·2." As to the overall speed of that train, it has to reverse at Gloucester and its stops are rather crowded together in the early part of its journey, more so than those of the Leeds train.

Comparison between locomotive work over level and undulating tracks is almost impossible. It is often contended that the latter are really the easier, unless the gradients are really steep or there are speed restrictions. It is certainly harder to get going on the level at 80 or thereabouts than to hit up 90's on long downhill stretches, and "rushes" of the latter kind will often carry a train to the top of a succeeding rise with little effort. Level roads have been described by drivers as "uphill both ways," and the term is apt. Can we not praise the L.N.E. for its enterprise without attempting to assess its relative merit against the Great Western?

HORACE MYER, Major.

London, N.W. 3, May 9th.

SIR,—Your correspondent signing himself "D. T. L." in your issue of the 6th inst., states that the locomotive work involved from Grantham to London by the up Leeds express is more arduous than that of the G.W.R. "Cheltenham Flyer" from Swindon to London, and with this I think every one will agree, but he makes rather an odd mistake with regard to the gradients from Swindon to London. The first 24 miles from Swindon are on a down grade of 1 in 750, and the rest is level, and Paddington is below Swindon. The comparison, therefore, is even more in favour of the L. and N.E.R. than your correspondent indicates.

H. R. SUTTON.

Reading, May 7th.

### ATMOSPHERIC RAILWAYS: THEIR PAST, AND POSSIBILITIES.

SIR,—It is almost unknown to the younger generation of engineers, and has probably been forgotten by many of the older ones, that about ten years after the opening of the Liverpool and Manchester Railway, which appeared to have firmly established the locomotive as the most suitable moving power for railways, a rival system was introduced, which for a time seemed quite formidable, and had many advocates, among whom were Farey, Field, Brunel, Vignoles, and Cubitt. The trains were drawn by a piston in a tube, laid between the rails, from which the air was exhausted by stationary engines.

The pioneer of this method—whose activities did not, however, go beyond the publication of pamphlets on the subject—was a manufacturer of weighing machines in Soho, named George Medhurst, who wrote between 1810 and 1827.

The next projector was John Vallance, of Brighton, who put the whole train in a tunnel and constructed a short experimental line in 1826.

Another inventor in the same field was Henry Pinkus, who made extravagant claims, but really only contributed a suggested solution for the problem of keeping the longitudinal slot air-tight, proposing to use a flexible cord for this purpose. In 1835 a prospectus was issued of the "National Pneumatic Railway Association," to exploit his patent, but it failed to materialise.

We now come to Clegg and Samuda, who were very nearly successful. The longitudinal valve, designed by the former, consisted of a strip of leather, riveted between two iron plates, and was kept tight by a lip descending into a mixture of beeswax and tallow. In the course of some preliminary experiments at their works at Southwark, with a tube "about the diameter of a tumbler," they drew thirteen people and 13 cwt. of iron up an incline of 1 in 30. In June, 1840, they laid down an experimental line of about half a mile in length at Wormwood Scrubbs, and the results raised high hopes. The steam engine, though only 16 horse-power, nominal, could propel 43½ tons up a gradient of 1 in 115 at 20 miles an hour, and 5 tons at 45 miles per hour. These weights seem insignificant, but it must be remembered that in those days a first-class carriage only weighed about 4 tons.

In consequence of the results obtained on this experimental line the system was put into practical application between Kingstown and Dalkey, the Government granting a loan of £25,000 for the purpose to the Dublin and Kingstown Railway Company. This line was set to work in August, 1843. It was single, about a mile and three-quarters long, with an average gradient of 1 in 115, and sharp curves. The tube was 15in. internal diameter and the engine of 100 horse-power. Weights of 30 tons could be drawn up at 30 miles an hour and 70 tons at 20. As much as 57½ miles an hour was attained. This railway operated from 1843 to 1855 quite satisfactorily, the chief reason for its abandonment being an extension to Bray, which was to be worked by locomotives, and the consequent inconvenience of having a portion in the middle of the line from Dublin to Bray on a different system.

The next atmospheric railway was from Forest Hill to Croydon, a distance of 5½ miles, which was opened in the latter part of 1845, and continued northwards to New Cross in January, 1847. A prospectus of the "Dorking, Brighton and Arundel Atmospheric Railway"—capital a million pounds—cited the Croydon line as having exceeded the most sanguine anticipations, and as proving that railways constructed on the atmospheric principle must eventually supersede all others. However, it was purchased by the Brighton Railway and the system was abolished. Here again the inconvenience arose of having a section connected with locomotive lines at both ends.

A third example was the Paris and St. Germain Railway, which was opened in 1847 and worked with great regularity for about six years, when the traffic became so heavy that the power of the engines was insufficient to cope with it. Nevertheless, the line struggled on till 1860. During the whole period of nearly fourteen years there was no accident nor suspension of the service; but at last it became obvious that a complete reconstruction was necessary to deal with the traffic, and the improvements that had come about with locomotives, which rendered them capable of hauling the trains up the inclines, led the directors to decide on the abandonment of the system. The line started at a place called Nanterre, 7½ miles from Paris, and went on for 5½ miles to St. Germain, the last mile and a half being for the most part on a gradient of 1 in 28½, on which the tube was just under 25in. in diameter.

The last, the most ambitious and the least successful, instance was the Exeter-Newton Abbot section of the South Devon Railway, which was opened in January, 1848, and abandoned at the end of the year. This line never worked satisfactorily. Considerable trouble was given by the stationary engines, and the longitudinal valve for some reason behaved much worse than it did elsewhere. An important contributory cause of the failure was an unfortunate delay in establishing the telegraph, which necessitated working the pumps sometimes for long periods uselessly, when the down trains were late.

No one can say that the system with the trains outside the tube did not have a fair trial, nor that it could be revived with any hope of success. But the other method of atmospheric working, namely, enclosing the whole train in a tunnel, has never had a chance of showing what it could do. Probably nobody has given it a thought for over a hundred years. Yet it has such remarkable possibilities that a short inquiry into the matter will, it is hoped, be found of interest as being an unopened chapter in railway science, even if it is considered a purely academic study.

The tunnel principle offers a means of obtaining high-speed locomotion at about half the expenditure of power required by any other system. As compared with an ordinary railway, the air resistance is eliminated, which is about half the total at ordinary express speeds and very much more at exceptional ones. Not only that, the resistance of the engine is also cut out, to say nothing of the wear and tear due to the latter, against which, of course, there is that of the stationary motors, which would be very much less.

In comparison with the old atmospheric lines, on which the resistance was extremely low, the absence of the air resistance reduces it by much more than a half. Even at only 35 miles an hour, Robert Stephenson, who gave an elaborate report on the Kingstown and Dalkey line, estimated that the external air resistance absorbed 78 out of 150 horse-power. The Achilles heel, namely, the longitudinal valve, would also be dispensed with.

It is obvious at once that a tunnel constructed expressly for the purpose would be very expensive, and highly unpopular with travellers. But the case is quite different if a tunnel is necessary in any case, such as in a tube railway, or going under the sea, or a river, for example. It could not be used for the Channel Tunnel, as the distance between the engines would be too great; but, in the opinion of the author, there is no difficulty in applying it to a tunnel under the Solent, and whisking people across to the Isle of Wight in a couple of minutes. Another possibility is a tube railway—which is very badly wanted—from Victoria to the Marble Arch. A fine opportunity was lost when the old Mersey Tunnel was converted from steam to electricity.

Let us consider a scheme for the Solent. The tunnel would naturally have gradients at the ends, which would assist the starting and stopping. One of the carriages would be fitted with about half a dozen transverse fins of india-rubber, very nearly filling the tunnel, which would form a kind of labyrinth packing, and make the leakage of no consequence.

It will, of course, be agreed that if the scheme can be shown to be feasible for an ordinary train, the expenditure of power would be very much less if one of the tube type were used; but this, of course, would involve the passengers changing at the ends, as they have to do now, with the boats. We will suppose, therefore, that the tunnel is made to take ordinary stock, and that on arrival the locomotive is taken off and a "piston carriage" substituted, which could take local passengers and luggage.

With the old system, a relatively small amount of air had to be removed under a high vacuum. Here the converse occurs; we have to extract a very large volume of air at practically atmospheric pressure, which, of course, suggests fans. Let us suppose it is holiday time, and take a train like the Scotch express of 1913, the features and running of which were discussed in detail in the author's book, "The Resistance of Express Trains." The resistance formula for this train without the engine is:

$$R = 1{\cdot}47 + 0{\cdot}053\,V + 0{\cdot}0016\,V^2.$$

The last term, which represents the air resistance, would not be correct for running in the open, as it assumes that part of the frontal pressure is screened off by the tender; however, this point is immaterial, because we cut it out, and are left with $1{\cdot}47 + 0{\cdot}053$ V pounds per ton, or $529{\cdot}2 + 19{\cdot}08$ V pounds actual. At 60 miles an hour it is 1674 lb., which is all the pull required from the air, the acceleration up to that speed having been acquired from the approach gradient. The area of a tunnel with flat sides to fit this train would be 82 square feet, so that the suction required is 20½ lb. per square foot, or about 2½ oz. per square inch, which is under ½in. of mercury.

The horse-power for a given pull is

$$\frac{p\,V}{375} = \frac{1674 \times 60}{375} = 268.$$

We have also to clear the air away from in front of the train. If the tunnel is 3 miles long, its volume is $5280 \times 3 \times 82 = 1{,}298{,}880$ cubic feet, so we have to draw out 433,000 cubic feet per minute. The ventilating system proposed for the new Mersey tunnel is designed to deal with 2½ million cubic feet per minute. A fan at the National Physical Laboratory, 11ft. 6in. in diameter, extracts air from a 7ft. tunnel at the rate of 258,000 cubic feet per minute, for an expenditure of 200 horse-power. Consequently, 350 H.P. is the order of the power required to move the air, which, added to 268, makes a total of 618, as compared with 1350, which was about the power developed by the engine of the train in question at that speed.

Evidently, in the case of a tube railway, the power required would be absurdly small. It would be desirable to have larger wheels than is usual on these trains, as there is no reason why speeds very much higher than 60 miles an hour should not be attained. In fact, the plant could be designed to produce the very highest speed that was considered safe.

In the case of the Berlin-Zossen high-speed car of 1903, the total resistance at 120 miles an hour was just under 2½ tons, of which no less than 2 tons, or 80 per cent., was due to the atmosphere.

May 9th. C. F. DENDY MARSHALL.

## WATER DIVINING.

SIR,—Whatever criticisms may be levelled at the dowser's operations, the fact remains that he is born with the gift, and I have never heard of anyone who can acquire by practice the uncanny divination he possesses.

I have a brother in Canada who can spot not only water but oil, and has never yet failed. I was with him a couple of years ago, and we visited the Turner Valley oil fields. As we walked along the wooden-shack townlet which has sprung up there, he picked up a piece of wire and told me in a low voice to watch him, as he was going to "do his stuff." He then bent the wire into the rough semblance of a bow, holding an end in either hand, with the knuckles downwards and the bulge of the wire away from his body and parallel with the ground. As we walked along, he managed to hold the wire in this way without attracting attention, and I was both interested and surprised to see the wire twitch downwards several times.

He has spotted quite a large number of wells in the small town in which he lives, but always does this work on an amateur and friendly basis, refusing to accept any payment.

He uses a "rod" made from silver wire of about $\frac{1}{16}$in. square section, bent somewhat in the shape of a bow and held as I have described above.

I tried my hand at the job, but after tramping about in the snow round his house, which is well out in the country, and getting hands and feet half frozen, gave it up, as I could not get the wretched wire to show any interest in the proceedings, and decided I had not got the necessary "'fluence." My brother, on the other hand, got marked twitchings of the apparatus as he walked along the verandah.

I might add that he replied to an advertisement issued by the Australian Government a couple of years or so ago, for people who could "spot" oil by the diviner's method, but never heard what the outcome was.

F. N. B.

London, E.C. 2, May 5th.

## A WORKS DEMONSTRATION AT IPSWICH.

On Wednesday and Thursday of last week, May 4th and 5th, Ransomes and Rapier, Ltd., arranged at their Waterside Works, Ipswich, an interesting and varied display of their products, which were for the most part demonstrated in operation. On both days a large number of engineers, contractors, and municipal officers attended. After a short tour round the works, luncheon was served in the new erecting shop, after which the party was divided into convenient groups and a more detailed inspection of the shops and exhibits was made. The chairman of the company, Mr. R. R. Stokes, and Mr. A. S. Stokes (director) assisted by the technical staff, acted as guides. In going through the works we noted in course of construction several crab winches, which have been specially designed for the lifting of sluice gates for the heightened Aswan Dam. The model river for testing various types of water control gear aroused considerable interest. Among the excavators we may single out for special mention a 3 to 3½ cubic yard electrically driven excavator, specially built for digging shattered limestone from the quarry face. It is being supplied to the Bundi Portland Cement Company, Ltd., of India. The machine is operated by 3300-volt A.C. supply converted to D.C. An outstanding exhibit in the mobile crane department was a new 1-ton four-wheel truck crane, operated by a small petrol engine and fitted with a telescopic jib designed to load on its own platform or, in a lowered position, to travel through a low door. The extreme mobility of several different kinds of mobile cranes was convincingly illustrated. There was also shown a series of concrete mixers, including a new 4-ton pattern with a modified design of gearing, giving an exceptionally low centre of gravity, while a new oil-electric shunting locomotive and several small oil engine driven locomotives were also seen in operation.

In collaboration with the allied firm of Cochran and Co., Ltd., of Annan, there was a boiler display, comprising a 1000 square foot, 100 lb. Cochran boiler, a 335 square foot Cochran-Hopwood boiler, and a small Cochranette hot water boiler. The firm is to be congratulated on the excellent arrangements which were made.

## British Standards Institution.

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### DERRICK CRANES (POWER-DRIVEN).

No. 327. A revision has just been issued of British Standard Specification No. 327, Part I., Power-driven Derrick Cranes. In view of the recent requirement of the Building (Amendment) Regulations that all cranes used for the purpose of constructing a building or any addition to the structure of a building shall comply with the specification, the revised British Standard is of the greatest importance to builders and contractors, as well as to those authorities concerned in the erection of buildings. The modifications that have been made to the specification all lie in the direction of a slight easing in the stringency of the design requirements. The general factor of safety has been lowered to a minimum of 4½, but no change has been made to the minimum factors of safety of gearing or wire ropes or the maximum allowable working stresses for certain other component parts. In view of the wide differences in the methods of calculation in vogue by different firms, the factor of safety of gearing has had little meaning to the average crane user in the past, and on this account it is of interest to note that the Institution recommends that the factor of safety of gearing should be calculated in accordance with B.S.S. No. 436, Machine-cut Gears, which is about to be issued.

While no mandatory instructions are included for the calculation of the stresses in struts, a fully detailed method of calculation has been recommended as a guide to designers and users. In this method provision is made for struts subjected to combined axial compression and bending, and there is some allowance for an increased stress at the extreme ends of struts of uniform section and for struts in which the slenderness ratio is based upon the least radius of gyration of any cross section throughout their length.

As hitherto, all derricks have to be subjected to load and overload tests, and a test certificate has to be furnished with the machine.

It is indicative of the general progress that is being made in the art of gas and electric welding that the specification now permits, where agreed between the buyer and the maker, the use of fusion welded joints.

A detailed list of the statutory regulations affecting cranes in Great Britain is included as an appendix to the specification. Other appendices deal with the information which should be furnished by the user with the inquiry or order and by the maker. A list of all British Standard Specifications to which the crane maker has to work adds to the utility of the specification.

### NEUTRAL TRACK RELAYS.

No. 452—1932. This is the second of a series of specifications in course of preparation dealing with railway signalling apparatus. In the past, the specifications in use by colonial railway companies have been very largely based on American practice. In the preparation of a specification specially directed towards meeting both British and colonial conditions, the experience gained by manufacturers and users in connection with the well-known specification issued by the American Railway Association has been of great value, and in the course of its work the B.S.I. Committee has been in touch with the A.R.A. It is, therefore, confidently expected that the new British Standard Specification will rapidly become adopted by the British railways, and eventually by colonial administrations. It is of interest to note that the specification provides for two grades of relay, one having a particularly high performance and the other corresponding very closely to the minimum requirements of the American specification. In addition to the electrical performance, certain mechanical features are dealt with in the specification.

### COPPER FOR ELECTRICAL PURPOSES.

No. 444—1932, No. 445—1932. These new specifications deal respectively with plain dead-soft copper strip, bars and rods for the windings of electrical machines (No. 444—1932), and copper commutator bars for electrical purposes (No. 445—1932). Both specifications include requirements for conductivity and tensile properties, whilst in the case of the commutator bars Brinell hardness tests and Shore scleroscope tests are given for application at the option of the purchaser. The selection and preparation of samples for the electrical and mechanical tests is dealt with and clauses relating to testing procedure are included.

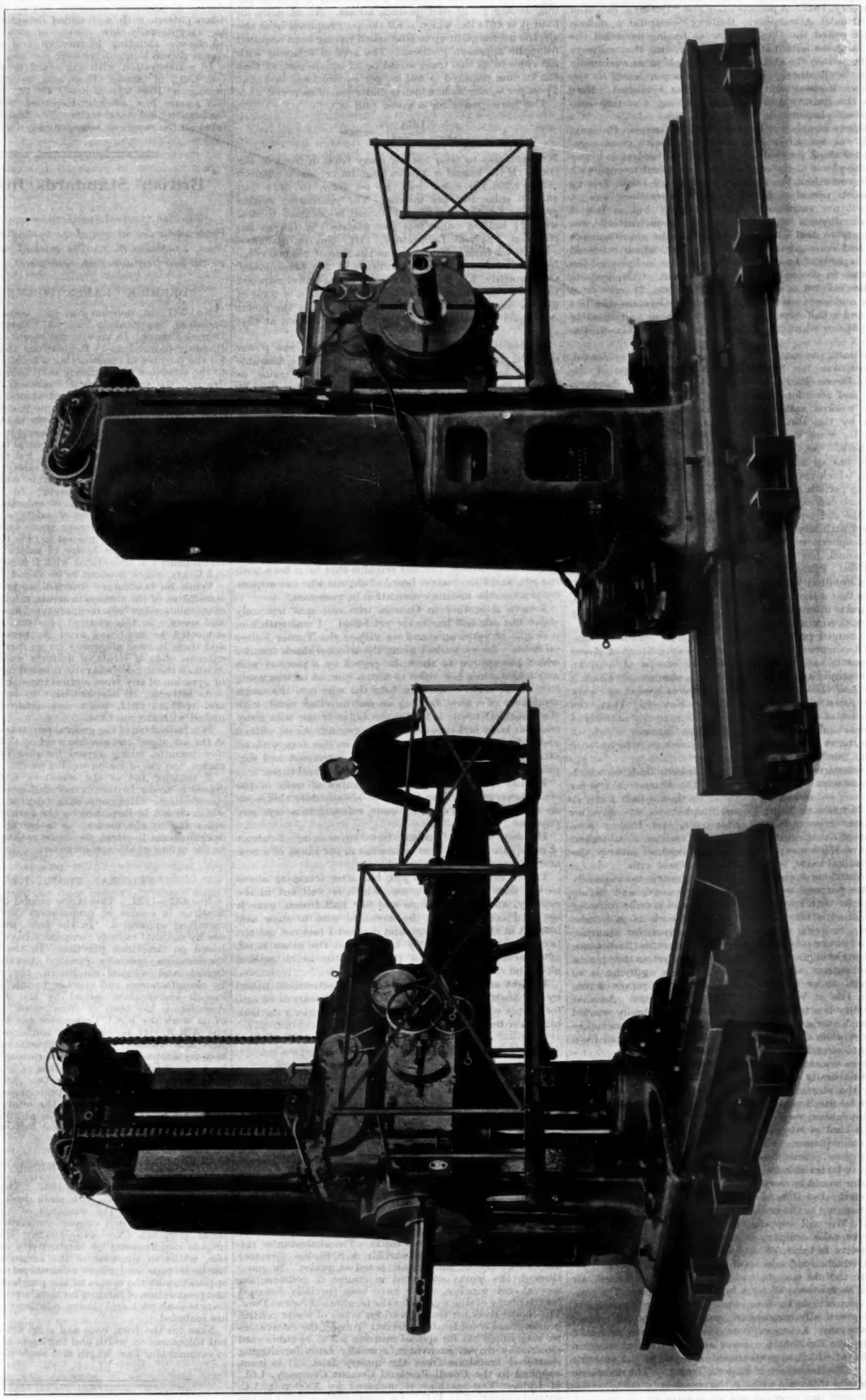
Sizes for the bars, rods and strip are not standardised, but tolerances on width and thickness are, and in the case of commutator bars length and angle also.

THE Stationery Office published on May 4th the preliminary statement as to the railway accidents reported in 1931.

## 6-INCH HORIZONTAL BORING, DRILLING AND MILLING MACHINE

WILLIAM ASQUITH LTD., HALIFAX, ENGINEERS

(For description see opposite page.)



## A 6in. Horizontal Boring, Drilling and Milling Machine.

THE photographs reproduced opposite show a large 6in. horizontal boring, drilling, and milling machine recently constructed by William Asquith, Ltd., of Halifax, for Russia. We had the opportunity to inspect this machine in the maker's works before it was despatched, and were much impressed by the ease with which it could be controlled, the concentration of the levers within a small space on the slide, and the very complete interlocking which makes the machine—as the saying has it—fool-proof.

While the engravings give some idea of its size, the capacity of the machine is better judged from the following particulars :—

Facing, up to 5ft. 6in. in diameter.
Boring, up to 4ft. 6in. in diameter.
Drilling, up to 8in. from the solid.

Milling cutters up to 30in. in diameter on the barrel and up to 18in. in diameter on the spindle can be accommodated.

A carefully thought-out system of internal ribs gives the traverse bed section great strength to resist torsion and bending. The ways of this casting are of generous dimensions, while for the attachment of work plates projecting lugs with machined faces are provided along the front face.

The column, too, is of substantial section. The switch-gear is mounted in a box at its front side, the door being a quite heavy casting to conform with the general proportions of the rest of the machine. The fast power traverse 7½ H.P. motor is mounted near the base of the column immediately above its gear-box and operates upon the column by means of a helical tooth rack and pinion mechanism. By including within the gear-box a lubricating pump automatic lubrication of the ways is ensured whenever a traverse is in operation, and in order to keep the bed ways clean and ensure for them a long life wipers are fitted at the foot of the column.

The main slide moves upon amply proportioned ways on the column and is balanced by weights slung within the column on link chains passing over pulleys mounted at the top of the column on ball bearings. The slide itself is a box section casting, to the back of which is bolted the back feed bracket carrying the outer support of the spindle and its feed mechanism. The spindle is made from high-tensile heat-treated steel, is bored and ground to standard Morse taper, and has a specially recessed end face for driving large bars. At the front it is located in the barrel by a split taper bush ground inside and out, which is forced against a taper bore in the sleeve and at the back it is carried in a plain bearing. At this point there is also a heavy ball thrust washer. The spindle feed is obtained by means of a large screw carried by the rear bracket. When a milling cutter is attached to the spindle it is necessary to lock this mechanism, and a handle is provided for the purpose on the top of the feed nut. The various parts of the slide are lubricated from a pump carried in the gear-box. With the exception of the pressure-lubricated front bearing of the barrel lubrication is by cascade throughout. A visible oil indicator is mounted on the top of the slide.

All the controls for the machine are concentrated upon the slide, so that the operator has complete command of the various motions from the platform. The upper of the two-faced panels contains all the gear change levers for the spindle speeds. For each of the three positions of the left-hand lever the speed disc on the right gives nine alternative speeds. Thus in all twenty-seven speeds are available, the one in use being shown by the indicator on the speed disc. The levers on the lower panel and the separate speed disc at the right control the rates of feed. Since the machine is suitable for drilling, boring, and milling, three kinds of feed are available. The particular kind of feed engaged depends upon the position of the lever in the top left-hand corner of the panel. For drilling and boring there is a direct relation between the spindle speed and the rate of feed. Nine rates of feed are available by the use of the nine-speed feed disc on the right for each position of the speed control lever at the left of the top panel. When the feed control lever on the lower panel is in the drilling position the twenty-seven feeds available range from 0·008in. to 0·1in. per revolution of the spindle. For boring, by altering the setting of the feed control lever, twenty-seven coarser feeds can be obtained, ranging from 0·01in. to 3·25in. per revolution of the spindle. Drilling and boring feeds are all available in either direction. The third position of the feed control lever provides nine rates of feed suitable for milling. As before, the required feed is selected upon the nine-speed feed disc. It can be applied to the column, along the bed, or to the slide along the column, or both together by the use of the two superimposed levers at the centre of the lower panel and is quite independent of the spindle speed. The feeds available range from 1in. to 12in. per minute. When a milling cutter is mounted directly on the face plate it can be brought up to the work by means of the lower of the two hand wheels, which provides a 3in. adjustment of the barrel position. A small lever to the right of the wheel locks the barrel in the required position, whilst the other hand wheel, seen in our illustrations, gives fine hand adjustment of the spindle.

The spindle is stopped, started, or reversed by means of a switch lever mounted on a small panel at the extreme left of the slide close to the work. Below this lever are two push buttons controlling the 2 H.P. motor of the spindle power traverse. Two other switch levers mounted near the top of the front end of the slide control the power traverse motors, of 3 H.P. and 7½ H.P. respectively, for the slide along the column and the column along the bed. The main driving motor is of 15 H.P. The fast power traverses give a rate of movement of about 5ft. per minute, and each, it will be observed from the foregoing, has a separate driving motor.

Interlocking of the controls is very complete. On the top of the slide there is a visible indicator which shows a red light when the first motion shaft is running and a green light when it is stopped. When the red light is burning all the gear change levers are locked in position. The fast power traverse switches are interlocked with the feed levers and are inoperative if any self-acting feed is engaged, whether the spindle is running or not. A further safety device is the fitting of adjustable limit trips on the bed and on the column.

The machine which we inspected is equipped for use with A.C. current, but future machines will be available for use with either A.C. or D.C. The weight of the machine as illustrated is 25½ tons. The method of finishing the faced surfaces is of interest. In preference to the more usual method of finishing these surfaces, Messrs. Asquith have adopted draw scraping. They find that for large machines such as this the appearance is much improved by adopting this method, while at the same time the finish is perceptibly smoother.

## Experimental Work on Welds.

THE technical report for 1930–31 of the British Engine, Boiler, and Electrical Insurance Company, Ltd., records a number of experimental investigations of the satisfactory or unsatisfactory nature of welds. We give below an abstract of that part of the report which deals with this subject.

### THE DETECTION OF DEFECTS IN WELDED JOINTS.

Many methods of testing welds for defects, without serious damage to the joints, have been discussed in the technical Press, *e.g.*, acoustic, X-ray, and magnetic methods. Each method presents certain advantages, but none is entirely satisfactory, because each requires the use of apparatus with which the usual shop foreman or inspector is not acquainted, and because each requires a certain amount of special skill in its use. For these reasons the company has recently made a few trial examinations of welds specially prepared by the Straight Away weld testing method originating in Germany. The method has the advantage that, on account of its simplicity, it appeals directly to any engineer or manufacturer. The special apparatus consists of an electrically driven vertical milling machine, which is tack welded on to the top of the joint. It merely mills a hole in any position of the joint, and a forward travel makes the hole oval and allows an increased area of weld metal to be examined. It is a simple matter afterwards to fill in the hole with fresh weld metal. The hole, when made, can, if so desired, be etched up to make evident the various runs of metal and the junction of the weld and the parent metal.

This method of testing welds appears to have excellent possibilities for practical application. At the same time, although serious defects wherever exposed at the surface of a hole were detected with ease, the surface of the holes in the angle welds and the reinforced butt welds was too rough to allow detection of minute defects. The poor finish was doubtless due to the fact that the specimens were small and of awkward shape, and that for this reason the machine had to be packed up temporarily and was not rigidly attached to the welded part, as intended. At any rate, the objection would have been overcome if the holes had been polished, and this polishing could have been carried out by means of a polishing cone supplied with the equipment and driven off the same motor as the milling machine.

### WELDS BROKEN IN TENSION.

The type of defect considered here is exemplified by means of a butt weld that was broken during tensile test. It results in what appears to be a continuous line of blow-holes at the commencement of each run.

Sulphur prints of cross sections through this particular weld showed no reason for this irregularity. The reason was, however, made evident when sections were macro-etched. These showed that what appeared to be porous lines on the broken surface are in reality due to the coarseness of the structure of the metal at these parts, the grains appearing to be columnar. The structure could not be reproduced by means of macro-prints.

When viewed under the microscope, the defective parts were found to consist of coarse grains of ferrite containing a nitrogenous constituent giving the suggestion of a Widmanstätten structure. At the remainder of the surface of fracture the structure had been refined, and owing to the quick rate of cooling all nitrides were retained in solution.

A portion of the weld was normalised, when it was found that the whole cross section showed a uniform structure of ferrite, containing nitride needles.

Though it is common to find the form of fracture described at the top of a weld where the metal has not been refined, it is less commonly found at the bottom of each successive run. In the present instance, it would appear that the phenomenon was aided by the heavy mass of metal that was welded, and that each successive run of metal, as it was being deposited, was chilled by the surrounding plate, and therefore not given an opportunity of refining the bottom portion of the run below it. The refined portion probably benefited owing to the quick rate of cooling, as the grain size was smaller than usual, and the nitrogen—a small amount only—was held in solution, while the unrefined portion was, of course, less ductile than it should have been.

The peculiar surface of fracture resulted from difference in ductility of neighbouring layers, and it would not have occurred had a higher current been used.

### SPECIAL FORM OF JOINT.

The special form of interleaved joint, shown by the sketch, is used in America for pressure vessels. A sample

INTERLEAVED WELDED JOINT

to the dimensions shown by the sketch was made of 1in. plate for a tensile test, the surfaces of the joint being machined so as to ensure an accurate fit. Asbestos-wound electrodes were used for making the welds, and the joint was tested in tension.

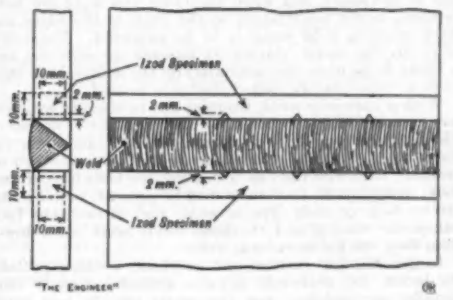
As a result of the tests, this type of joint does not appear to have anything to recommend it. It encourages the entrapping of slag at the bottom of the V. The underside of a V-weld in a pressure vessel should always be accessible for inspection, and it is always desirable that slag should be cut away at that part, after which a wash run of metal should be applied.

### RESISTANCE TO SHOCK.

The possibility that the heat of welding will bring about deterioration of the metal surrounding a weld often arises, and as injury is likely to be more pronounced as the carbon content of the plate is increased, it was decided to see to what extent deterioration could be shown up by means of notched bar impact tests.

Two qualities of plate were chosen, the one a shell quality boiler plate containing about 0·23 per cent. carbon and the other a furnace quality plate containing 0·18 per cent. carbon. The notches were all cut in the same direction and the welding was carried out alternatively by oxy-acetylene and by metallic-arc with a 10 s.w.g. asbestos-covered electrode with a current of 80 ampères, the metal being laid in two runs. The original thickness of the shell plate as welded was ½in., and of the furnace plate ⅝in., the thickness of all specimens when machined down being 10 mm. and a standard Izod notch being adopted. Two three-notch specimens were made of each type of weld, for comparison with specimens of the unwelded plate cut in a similar manner.

The welded samples were made as shown by the sketch, below, which also shows the method by which they were




POSITION OF IZOD SPECIMENS

afterwards cut up and notched. It is to be noticed that near the top surface of the plate the bottom of the notches was 2 mm. from the edge of the weld metal, but near the bottom surface it was further off. The samples therefore were not necessarily able to show the full extent of any change, owing to the gap between themselves and the welds. In every instance the notches were cut so that fracture took place along any drawn-out inclusions, not across them, and the cross section of the plates, when broken, showed a lamellar grain.

A second series of tests was made with corner welds. For these tests plates of the same quality were used, but they were first normalised. The welding was carried out as before, but this time specimens welded by the metallic arc with bare wire were included, the welding current being 125 ampères and the metal being laid in two runs.

The notches were made only 1 mm. deep, and partial compensation for this was effected by reducing the thickness of the Izod specimens by 1 mm., so as to give better opportunity for the bottom of the notch to lie at a part where the mechanical properties of the metal were changed.

The tests, owing to the comparatively small depth of the part where the structure was altered when compared with the depth of the specimen, were insufficiently delicate to show the full effect of any change. They gave conclusive evidence, however, that marked changes can occur. To what extent changes do occur will naturally depend to a certain extent on chance and special circumstances, such as the initial condition of the plate with respect to heat treatment, the variation in penetration, the current used for the various runs, the plate thickness, and the general design. Any reduction of impact value depends more on the time during which an area may have been heated to an excessive temperature than it does on the maximum temperature attained. Though greater depreciation is likely to follow with shell quality plate it does not follow that there will be any at all. With the proviso that a local part of the plate may easily be adversely affected, and the defect not shown up by a test, either quality of plate may be improved, owing to refinement of the grain. This, however, may be counterbalanced if the metal is chilled.

Though the tests show that with oxy-acetylene welding there may be a noticeable improvement with both qualities of plate, it must always be remembered that this does not show that the whole of the specimens are improved, and a very different result may be obtained with a test made to show the energy required to cause an initial crack at any part of the specimen. Judged by the test figures, it would not be safe to predict that, in practice, the change in shock value will be greater or less with any particular form of welding than it is with any other form. Any change depends largely on the original condition of the plate. Naturally, it is to be expected that an oxy-acetylene weld will always be the most adversely affected, owing to the greater volume of overheated metal. On the other hand, with metallic arc welding and a plate having initially a large grain size, it is reasonable, especially when the current has been low, to expect general improvement, but no general law can be given. Even where there is general improvement there may be some small area of the plate, especially near the top of the V, where the metal has locally been maintained at a sufficiently high temperature for it to have an overheated structure.

The tests do show that, however much a specimen may be adversely affected, the damage with any of the forms of welding tested does not extend an appreciable distance into the plate. Though in some instances they show very marked depreciation, in no instance do they indicate that really serious damage has occurred. Naturally these

results must not be applied to plate containing a higher carbon content.

### Overhead and Vertical Welding.

For some forms of pressure vessel and often for repair work, it is not possible to make all welds with the work lying horizontally below the welding appliance. Again, as is well known, it is more difficult to make a satisfactory weld when the plates to be welded lie either in an inverted position above the electrode—*i.e.*, overhead welding—or in a vertical position than when they lie horizontally below the electrode, sometimes referred to as "flat" welding. It was therefore considered that sets of samples, each welded in these different ways by the same operator, might allow useful comparison. For nearly all samples an angle of V of 70 deg. was adopted, and for comparison one set of samples was made by the oxy-acetylene process. A large number of tests were made, the particulars of which are included in the report. The conclusions reached were as follows:—

With metallic arc welding the situation may be summarised as follows:—

With an overhead weld there is the most difficulty in obtaining penetration to the back of the plate.

With a heavily coated electrode, provided that a suitable covering is used, it is possible to lay good quality weld metal when the plate lies overhead, or is vertical with the weld horizontal. Judged, however, by the results obtained, uniform success is not to be relied upon, and it is highly probable that the metal will not reach the back of the plate, which may be inaccessible for a wash run.

With a lightly coated electrode, the danger of entrapped slag is decreased, and when the plate and weld are both vertical, better penetration to the back of the plate and more uniform weld metal is to be expected. Naturally, however, the metal, during its passage through the arc, is likely to be more contaminated by the atmosphere than when a more heavily coated electrode is used.

With a bare-wire weld, troubles due to slag are avoided, but greater skill is required on the part of the operator. Though it is not to be expected that the ductility, the shock value, and the penetration will be so good when an ordinary bare-wire rod has been used, the tests have shown that, though oxide inclusions may be present, sound metal can be laid for each type of weld, and, in fact, the Izod values for vertical and overhead welds need be no lower than they are for horizontal welds.

In general, for vertical and overhead welds, especially the latter, oxy-acetylene is more difficult to apply than metallic arc welding, but the metal can be laid satisfactorily by an experienced operator. When the weld is accessible at one side of the plate only, poor or irregular penetration must be anticipated, and an inferior finish is to be expected.

### Contour of Fillet Welds.

As the contour of fillet welds is apt to vary with the conditions of welding and the shape of the contour is often a doubtful quantity, it was thought that a set of sulphur prints of welds, all made by the same operator, might allow useful comparison of the results to be obtained with different electrodes.

The instruction given was that the weld metal should be allowed to take up its natural formation and no special effort made to force the contour to a predetermined shape. The operator employed was accustomed to the use of both covered and bare-wire electrodes, and electrodes of both these types were used, connected alternatively positive and negative. For confirmation, two makes of electrode were employed, both when covered and after they were stripped of the covering. All the electrodes contained about 0·14 per cent. carbon, one set of covered electrodes being wound closely with blue asbestos and the other with turns of white asbestos with a paste in between; 10 s.w.g. electrodes were used throughout for all runs of metal.

Naturally the contour will be found to vary according to the plate thickness and the current used. A low current results in a convex and a high current in a concave profile. A smooth finish can be obtained by means of a wash run deposited with a high current. With a plate as thick as ½in., the final run is too wide for deposition with a single sweep of a thin electrode, and a thick electrode causes overheating with a small sample. It was therefore decided to adopt a ¾in. plate.

For each experiment the fillet was built up in two different ways. Two and three runs of metal were employed, three runs being the preferable practice.

For the covered electrodes a current of 80 ampères was adopted for the completely wrapped and 95 ampères for the partially wrapped electrode. Greater difficulty was experienced with the second type in controlling the slag, owing to its higher viscosity, especially with the electrode positive. For the uncovered electrodes a current of 120 ampères was used.

Though it was noticed that there was considerable variation in the penetration, the contour and the ultimate dimensions of the various welds, no type of weld showed a characteristic peculiar to itself, though with the second type of covered electrode there was more included slag than with the first. When made in the manner described, no weld showed a concave profile and any tendency was towards a convex profile. The contours, in general, were irregular, but the plates were laid flat and the contours would have been improved had the plates been tilted to assist the flow of the molten metal and the slag.

### The Use of Bare Wire in the Metallic-Arc Welding of Pressure Vessels.

As a result of exhaustive tests, the company has for some years looked upon the use of ordinary bare-wire electrodes for pressure vessels with disfavour. Since the last report they have had no reason for modifying past opinions. A claim for the use of bare wire that would seem to have considerable justification is that its use eliminates the entrapment of slag. It is true that with covered electrodes there is danger of slag inclusion. The operator may neglect to remove the slag before laying a subsequent run, adopt too low a current value and cause insufficient fluidity of the slag, or use an electrode having a slag covering with too high a melting point. Though the use of bare wire eliminates these factors, it by no means necessarily removes danger of equally poor metal. Inclusions may be present which are not accessible for the operator to remove.

Such faults refute the claim that bare wire welds are necessarily free from serious inclusions. The company's principal objection, however, to bare-wire welds as ordinarily made, lies in the low impact value.

For a part that does not have to withstand shock, it might, however, be argued that a good impact value is of no advantage. A complete reply to this would be lengthy, and involve an analysis of the behaviour of steel parts in service. Whether it is necessary or not that welds in a particular form of construction should have a good shock value naturally depends on the design and service of the part. For a pressure vessel it is only necessary to state that, if contaminated metal and a low shock value are considered to be satisfactory, a low-class merchant quality plate of the required tensile strength is equally satisfactorily.

### Heating of Electrode.

There is a mistaken notion that when an electrode is connected to the positive pole, it necessarily becomes hotter than when it is connected to the negative, and that for this reason the slag covering becomes more fluid.

In general, heavily coated electrodes are connected to the positive pole, and bare-wire or lightly coated electrodes to the negative. The principal reasons for this are as follows:—

When a bare-wire electrode is connected to the negative, control is more easy and the metal is laid more uniformly than with the electrode positive. In addition, penetration is better.

When a bare-wire electrode is connected to the positive, penetration is poor and the metal tends to pile up, instead of lying flat as required.

When a heavily coated electrode is connected to the negative, control is not so easy, more spluttering takes place and the slag is liable to be obscured. The tests showed that the electrode is actually hotter when connected in this manner than when connected to the positive, and for this reason a slag-covering having a comparatively high melting point becomes more fluid.

A piece of ¼in. diameter glass tubing, about 15in. long, plugged at the bottom with a rubber stopper, was employed for one test. This at the commencement of each test was filled with 25 c.c. of water, into which a thermometer was immersed to a given depth. Similar 10 s.w.g. bare-wire mild steel electrodes, 18in. long, were used. These were first annealed, and then marked at a distance of 9in. from the free end by means of an asbestos thread.

One electrode was connected to the positive pole and another to the negative, the current being maintained at 125 ampères and the same arc length adopted. In turn, an arc was struck between an electrode and a plate until 9in. had been consumed, after which the unused portion was immediately dropped into the glass tubing, the water stirred, and the temperature of the water taken. The result showed that with the electrode negative the temperature rise of the water was double what it was with the electrode positive, so that it is quite clear that the electrode is heated considerably more when it is connected to the negative pole, and that the belief that the opposite obtains does not apply to welding when carried out in the manner adopted for the experiment.

Though the results that have been recorded were obtained with mild steel rods, it does not follow that similar results are obtained with rods of other composition. In fact, observations on rods containing high manganese or chromium tend to show that the relative heating at the two poles is reversed. Time did not allow an extension of the experiments, but from the facts given it would appear that many interesting points would be brought out by their extension.

### Welded Monel Metal.

A small sample of monel metal plate, which had been welded by the metallic arc and submitted to the company, was examined.

Fusion was good, but the parent metal had the grains slightly enlarged near the junctions.

The weld metal contained several blow-holes of appreciable size, but appeared to be clean under the microscope. The structure was dendritic.

A specimen that had been heat treated at 950 deg. Cent. for a quarter of an hour, allowed to cool to 900 deg. Cent., maintained at that temperature for a quarter of an hour, and allowed to cool to air temperature in the furnace, did not have the dendritic structure removed, but a few polygonal grains were formed near the junction.

However, after the specimen had been heated to 910 deg. Cent. for 3½ hours and cooled slowly in the furnace, the structure of the weld consisted almost entirely of polygonal grains, but the grains of the parent metal were larger than those of the as-received specimen.

When the microscopic specimens were etched it was noticed that, with as-received samples, the weld metal etched up at an appreciably greater rate than the parent metal. From this it is to be concluded that in service there would be a greater tendency for the weld metal to corrode than for the parent metal, but no marked tendency was noticed for corrosion to take place at the grain boundaries. As a result of the heat treatment, the tendency for the weld metal to etch rapidly was removed, as the structures were rendered similar thereby.

### Atomic Hydrogen Process.

This is a process that has proved exceedingly useful for certain articles, and one which the company would certainly welcome for the welding of pressure vessels, especially when adapted for automatic welding. The special virtues it possesses are freedom from atmospheric contamination, both of oxygen and nitrogen. One apparent difficulty of manufacturers is the obtaining of good tensile properties, owing to decarburisation brought about by the hydrogen. With this difficulty overcome, or with a suitable modification to the process, what seems to be an ideal metal can be laid. This said, it should perhaps be pointed out that the process is not necessarily free from fault, and care in operation and procedure is still necessary.

## The International Association for Testing Materials.

A general meeting of the British branch of the International Association for Testing Materials was held in the hall of the Institution of Mechanical Engineers on Tuesday last, with Sir Henry Fowler, President of the Institute of Metals, in the chair, and an address on the constitution and activities of the Association was given by Dr. W. Rosenhain, its President, to which we hope to be able to devote some space in a later issue.

Sir Henry Fowler recalled that the international organisation had its origin at a congress held at Amsterdam in September, 1927, when the action of the British delegates—Dr. Rosenhain and himself—which was supported by the delegates from America and Sweden, and later by those from Germany, succeeded in procuring the adoption of a constitution in conformity with British opinion. Under the constitution all the principal countries having metallurgical and other industries have the right to nominate one representative to a Permanent Committee, and the President is usually chosen from among the representatives of one of the four leading countries, namely, France, Great Britain, Germany and Italy, while the other three hold the office of Vice-president. The first President to be elected by the Permanent Committee was Mr. A. Mesnager, of France, who held office until 1931 and presided over the Zurich Conference in that year. Dr. Rosenhain was elected to succeed him.

In most countries the delegate to the Permanent Committee is elected by the national testing association there. In other countries, as, for instance, in Great Britain, where no such national organisation exists, the procedure varies. Here the leading institutions and societies were invited to affiliate themselves with the International Association and to appoint one representative each, to constitute a British Committee. Sixteen of these bodies responded to the invitation, including the Department of Scientific and Industrial Research, Lloyd's Register of Shipping and the British Standards Institution, and their representatives constitute the Committee. In 1931, in order to bring the individual members of the Association into closer contact with the work, it was decided to elect three of them to the British Committee. It was announced that the three elected, as the result of a ballot of the general body of members, were Mr. R. W. Bailey, Dr. C. H. Desch and Dr. Harold Moore.

In the course of discussion, Dr. Seligman asked if it were proposed to publish in the future, as had been done before, reports which had been received from contributing countries on various matters, within the ambit of the Association's work? Dr. Rosenhain replied that some sort of publication of intermediate matter between conferences would be made to maintain interest; but the method of their publication was dependent on financial resources.

Dr. R. S. Hutton (Director of the Non-ferrous Metals Research Association), who appealed for the support of those who were so worthily upholding the status of our country in these matters, by increased membership, pointed out that the Association could not be regarded as competing in any way for membership with any of our existing scientific societies. He suggested that it would help if there were a frank exposure of our weakness so far as numbers were concerned.

Dr. Rosenhain responded to this suggestion by stating that the membership of the British branch comprised only eighty-three individual members and thirty corporate members, as compared with a membership of over 300 in Germany, and in France and America. In explanation, however, he pointed out that the members of the national associations for testing materials existing in some of those other countries had become members of the International Association *en bloc*, and added their subscriptions to those paid to the national associations. It was the absence of a national body in this country which rendered the matter difficult. At the same time, he did not plead for the formation of such a body, and, indeed, had been averse to it, on the ground that there are too many societies already, and it would be difficult, if not impossible, at the moment to found a new body without rendering it difficult for those existing to make progress.

Dr. Seligman wondered whether it would not be better, rather than canvass for a large increase of individual membership, to rely mostly on the support of the existing institutions, for, after all, the work of the international body served to focus the work of those institutions. Dr. Rosenhain, however, felt that both individual and corporate members were necessary; on the Councils of some existing bodies there were no representatives of the International Association who knew of its work. Sir Henry Fowler also urged that individual membership did create added interest in the work.

The meeting closed with a hearty vote of thanks to Dr. Rosenhain for his untiring work on behalf of the movement over a period of many years.

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Speed regulation of two duplicate 75 H.P. direct-connected gas engines, states a writer in *Power*, was for years unsatisfactory when the attempt was made to operate them in parallel. Efforts by various operators to adjust the governors was simply a matter of trial and error. In due course, however, a practical operator came on the job who solved the trouble satisfactorily. He was of the opinion that the inability of the governing devices to operate properly was not the cause of the poor speed and hunting when the machines were connected to the same bus-bars. As an experiment he removed a 2in. pipe elbow located about 6in. from the cylinder on the gas line to the engines and put a tee in its place. Into the outlet of the tee he screwed a short nipple and connected to this a piece of inner tube of a motor car tire about 18in. long. The effect of this attachment was that upon each suction stroke of the piston the rubber tube would contract to about half its size, allowing the right volume of gas to enter the engine, without constriction. The immediate result was almost perfect operation.

## Railway and Road Matters.

THE Down-street station on the Piccadilly section of the Underground system will be closed on May 22nd. On the following day the new escalators and new booking hall will be opened at Hyde Park Corner station. More convenient entrances have been provided—one in Hyde Park and one by St. George's Hospital.

FOR the financial year April 1st, 1932, to March 31st, 1933, the South African Minister of Railways and Harbours, in his statement on March 24th, estimated the revenue for the year to be £25,997,571, an average of approximately £500,000 per week. Of this he estimates to obtain from harbours and steamships belonging to the Government £27,540 per week.

THE consolidation into one system of such important companies as the London and North-Western, Midland and Lancashire and Yorkshire, gave the London, Midland and Scottish four large rolling stock establishments, *i.e.*, Wolverton, Earlstown, Derby and Newton Heath. The progressive work done at those places, coupled with the less use of carriages and wagons, owing to reduced traffic, has rendered Newton Heath unnecessary and the carriage and wagon works there are about to be closed.

THE centenary of the first occasion on which a railway locomotive ran in the Midlands occurred on Thursday, May 5th. On that date 100 years ago the four-wheeled engine "Comet" made its inaugural trial trip near Leicester on the then unfinished Leicester and Swannington Railway, the first public railway in the Midland Counties, which was opened in July, 1832, and is now part of the L.M.S. Railway system. The "Comet" locomotive was built by Robert Stephenson and Co., of Newcastle-on-Tyne, and to get to the Leicester and Swannington Railway it had to be transported by sea from Newcastle to Hull and by canal from Hull to a point near Leicester. Robert Stephenson drove the engine on its trial trip on May 5th, 1832.

UNDER Section 59 of the Railways Act, 1921, it is provided that the Railway Rates Tribunal "shall review the standard charges and exceptional charges of each amalgamated company at the end of the first complete financial year after the appointed day . . . and . . . at the end of each succeeding year." The Tribunal has now announced that the next review will be on May 24th, and in reply to an inquiry as to whether the companies propose any modifications in the existing charges, their representative says that after a full consideration of the position and having regard to the industrial and economical conditions of the country, they are still doubtful whether a general increase of charges at the present time would result in any material improvement in their financial position, whilst the position of the companies' revenue is not such as to enable them to propose reductions.

THE London, Midland and Scottish Company has just brought into use between Repton and Willington station and Clay Mills Junction, a distance of 2¼ miles, on the Derby and Birmingham section, some colour-light signals of what are known as the Searchlight type. As explained herein on January 8th last, this type of signal, instead of having three separate lamps for the red, yellow and green aspects respectively, has one lamp, inside which is a frame which carries three colours and one of the three is presented between the electric bulb of the lamp and the lens as required. These new signals are advanced signals for the boxes named, and give the same traffic facility as an intermediate signal-box. They are, further, approach lighted, *i.e.*, the track circuit in the rear of the signal, when entered upon by a train, switches in the light; the clearance of the train in advance of the signal puts out the light.

ACCORDING to a contemporary, searchlight railway signals, which, although working on low-power electric current, throw a powerful coloured beam clearly visible in the brightest sunshine, have just been introduced on the L.M.S. Railway. The signals are lighted up only when the train is approaching within a certain distance of them, and are extinguished when the train has cleared the overlap section beyond. Any failure of the signal lamps is guarded against by a system by which they have to be tested as being in good order before the signalman can give an "all clear" signal into the section in advance. The signals have been installed by the L.M.S. on the main Derby-Birmingham line, between Repton and Willington, and Clay Mills Junction, Burton-on-Trent. The distance between the points of installation is 2¼ miles and the use of these signals, together with other electrically controlled apparatus, enables as many trains to be passed over this section as though there were an additional signal cabin.

THE collision on January 6th last between a down milk-empties train and an up goods train at the east end of Didcot station, as to which Lieut.-Colonel Anderson has recently reported to the Minister of Transport, was due to an error in working by the signalman concerned and to an irregularity by the driver of the milk train. The incident reveals some interesting features to secure safety in operation. Through Didcot East station there are four lines of way which, reading from the south, are the down main, up main, down relief, up relief. At Didcot East Junction there is what is known as a crossover junction, with facing points in the up main through which trains pass to the up relief and facing points in the down relief which lead to the down main. The goods train was travelling on the up main and had to be crossed on to the up relief. That operation fouled the down relief line on which the milk train was approaching. There were two courses open to the signalman in order to protect the two trains from crossing each other's path. One was to accept the milk train under the "warning arrangement," or to set the facing points in the down relief so as to lie towards the down main. The latter might not be done, as a newspaper train had been accepted on the down main and the setting of the facing points would obstruct—in a block working sense—that line. The signalman did neither of these things, but fully accepted the milk train and relied on the driver obeying the signals, which were against him. The driver, however, overran the signals, and as the facing points were lying for the straight line, the engines of the two trains met in a glancing collision.

## Notes and Memoranda.

A PLANT for the oxidation of ammonia into nitric acid under pressure by the Fauser system has just been started up at the La Madeleine works of the Kuhlmann Combine. According to the *Chemical Trade Journal and Chemical Engineer*, the plant will have an eventual output capacity of 350 tons of nitric acid a day, most of which will be transformed at the same works into the nitrates of lime, ammonia, or soda.

THE official returns rendered to the Electricity Commissioners show that 987 million units of electricity were generated by authorised undertakers in Great Britain during the month of April, 1932, as compared with the revised figure of 868 million units in the corresponding month of 1931, or an increase of 13·7 per cent. During the first four months of 1932 up to the end of April, the total amount of electricity generated by authorised undertakers was 4372 million units, as compared with the revised figure of 4061 million units for the corresponding period of 1931, representing an increase of 7·6 per cent.

SIX countries supply about 88 per cent. of the total aluminium produced in the world. In order of output, these countries are:—The United States, Canada, Germany, France, Switzerland, and Norway. Three countries, namely, France, Hungary, and the United States, supply 66 per cent. of the total bauxite ore required; four other countries, Dutch Guiana, Italy, British Guiana, and Jugo-Slavia, supply 32 per cent. of the bauxite. It has been estimated that about 75 per cent. of the bauxite produced is consumed in the manufacture of aluminium, the remainder being used chiefly in the manufacture of cement, refractories, and abrasives, and for the filtering of oil.

SOME time ago an investigation into safety on mine haulages was conducted by the Lancashire and Cheshire Coal Research Association. The collieries then forming the Association were visited and details were collected of appliances used and methods adopted for safety and convenience on the haulages. Much useful information was obtained, and a report has been prepared. Safety and economy are closely allied in haulage problems, and the Lancashire and Cheshire Safety in Mines Research Committee considers that assistance in achieving these two objects might be given to colliery managements by communicating to them certain of the information contained in the report. It is proposed, therefore, to issue a series of pamphlets on various haulage practices incorporating the best devices and methods described in the report.

A SWITCH, introduced by the General Electric Company, Ltd., is designed to eliminate noise. The problem has been solved without in any way reducing the speed of operation when making or breaking circuit. The switch embodies the underslung moving member of the ordinary "Landor" pattern switch, giving a long and rapid make and break, and comparative silence is obtained by the use of buffers against which the underslung moving member comes to rest. The buffers, which are fixed to the porcelain base, are made from a special non-perishable indiarubber compound selected to give the maximum life and minimum noise in operation. The switch is suitable for use in hospitals, libraries, churches, ships' cabins, railway sleeping berths, &c. It is made in surface, semi-recessed, and flush types with either one or two-way movements and has a capacity of 5 ampères.

THE outstanding characteristic of a new method of testing transformers, described by Mr. H. V. Putman in the *Electrical World*, is that the impulse test is applied while the transformer is excited at normal voltage, just as would be the case in actual service. Not only that, but the surge is synchronised with the crest of the voltage wave, so any fault which the surge might develop within the winding or the insulation would immediately be subjected to the maximum dynamic voltage available. The test, therefore, represents the worst possible condition which could occur in service. Any failure which might give trouble in service would immediately be detected by the flow of dynamic power into the fault developed by the surge. This kind of a test is a convincing demonstration of impulse strength, because it duplicates the exact conditions under which a transformer must withstand surges in service.

WHEN work has to be done on high-tension overhead lines, states the *Electrician*, great care has to be taken that the line is cut out of circuit, and to ensure safety it is desirable to earth the line at the point where work is in progress. General Reibel, who designed a line-throwing gun for use in the French merchant service, has developed a very light gun that throws a steel arrow and flexible steel line over a high-tension line and connects the conductors to earth by means of a metal peg driven into the ground. The earth connection is first made, the arrow, which weighs about 7 lb., is put into the gun weighing about 27 lb., and by pressing a button a cartridge is fired. The arrow with the line is thrown over the aerial conductors, the weight of the arrow keeping the earthing cable in contact until the work is completed. This apparatus, made by Messrs. Edgar Brandt, of 101, Boulevard Murat, Paris, is being used by several power companies in France.

REMARKABLE improvements in the Maier process for the reduction of zinc ores by the use of natural gas were recently announced by R. S. Dean at the meeting of the American Zinc Institute in St. Louis, Mo. These improvements, which, it is believed, furnish the final steps in making this radically new zinc process successful, are the result of a year's further experimental work by the Bureau of Mines at its Reno, Nevada, and Berkeley, Calif., stations, following the announcement of the discovery of the process at the Institute's meeting a year ago The Bureau of Mines metallurgists have developed a new contact material, and the difficulties encountered in large-scale experimentation on the process have been overcome by the use of this catalyst, which is placed in the retort just before the gases enter the condenser. This catalyst causes the complete elimination of oxidising gases even when the process is operated at higher temperatures and rates than heretofore possible. The essential features of the process are:—Continuous downward flow of calcine through a metal retort at temperatures of 1050–1100 deg. Cent.; concurrent flow of natural gas to secure intimate contact with calcine; and treatment of gases resulting from reduction with excess methane in the presence of a special catalyst.

## Miscellanea.

THE application of the Parys Municipality to be allowed to use more water from the normal flow of the Vaal River for power purposes has been granted by the River Authorities, and the Municipal Council will now be able to call for tenders for the carrying out of the change-over of their electrical system from D.C. to A.C. The cost is estimated to be about £20,000.

ON April 27th the Minister of Transport gave an assurance, in reply to a question addressed to him, that whilst it was not possible to offer the National Safety First Association and the Pedestrians' Association direct representation on the Road-Rail Conference, all interests concerned would have an opportunity of expressing their views before any action was taken as to the findings of the Conference.

THE following statistics with regard to municipal power costs are not without interest:—For the Municipality of Cape Town for the year ended December, 1930, the current sold was 65,171,659 units, average cost 2·16d. For the year ended June, 1931, the electric current sold by the Johannesburg Municipality was 92,584,539 units, average cost 1·90d. For the year ended July, 1931, the total units of electricity sold by the Durban Municipality was 96,813,746, average cost 1·29d.

GRAVE anxiety is felt by members of Parliament of all parties who are connected with the coal industry at the paralysing effect of import restrictions in foreign countries on British coal exports. The effect of these restrictions within recent weeks, states the *Birmingham Post*, has assumed serious proportions. It is probable that when the next returns are issued coal exports will be found to have fallen, in a month, by the equivalent of 6,000,000 tons a year, a decline which entails unemployment for some 23,000 miners.

THE expert consultant appointed by Burton Town Council last December to advise on the position of the Burton gas undertaking, has forwarded his report. It is understood that it states that on the manufacturing side the undertaking is, on the whole, efficient and up to date. On the question of sales, the report is believed to advise a thorough overhaul, it being considered false economy and a mistaken policy to restrict advertising and publicity. It is recognised that the undertaking is suffering from the general trade depression, as is every other business.

WE learn from a paragraph in our contemporary, the *Glasgow Herald*, that negotiations have now been completed whereby a flying ground is to be prepared at Hatston, near Kirkwall, for use as an air station. Kirkwall is the capital of the Orkneys, and it is hoped that it will be possible to open a northern air mail and passenger route to the islands next month. The scheme is being developed by the North British Aviation Company, and the air service will link the Orkneys with Wick, Thurso and Inverness. The journey from Wick or Thurso will take about twenty-five minutes, and from Inverness about one hour.

A FEW days ago a plan for the State scrapping of obsolete ships was put forward at the annual meeting of the Federation of Engineering and Shipbuilding Trades at Bournemouth. Reports received from various shipbuilding centres showed that about 2½ million tons of British shipping—or about 30 per cent. of the whole—was either obsolete or uneconomic. The conference suggested that the ships which this tonnage represented should be scrapped and the Government be asked to buy the scrap and sell it whenever a favourable opportunity arose. This, it was maintained, would enable orders to be placed for up-to-date ships, thus providing work in shipbuilding yards.

ACCORDING to the *Electrician*, installation of a fourth generating set of 30,000 kVA at the Ardnacrusha (Shannon) power station is under consideration by the Irish Free State Ministry of Industry and Commerce, and it is understood that legislation will be introduced during the present session of the Dail to provide for the extension at a cost of about £300,000. If the demand for current continues to grow at the present rate the maximum capacity of the existing plant—90,000 kVA—will be exceeded during next winter, when the estimated demand will be about 150,000,000 kWh. The steam standby plants at Pigeon House, Dublin, and at Cork, have capacities of 31,000 kVA and 5000 kVA respectively.

IN connection with the Sussex County Agricultural Show, the Sussex County Agricultural Society has asked the electrical undertakings in the county to join together to put up an electrical demonstration and exhibit in the educational section. Eastbourne Electricity Committee reports that it has decided to exhibit on commercial lines only, and, as far as possible, apparatus of British manufacture will be used. It is also understood that Mr. Frowd, an Eastbourne farmer, will permit his cows to be milked by electrical machinery, and he is to be asked to co-operate in demonstrations of butter-making and cutting by means of electric power. In the domestic section one bay will be fitted as an electric kitchen, one as a sitting-room, and a third will be used for the display of electrical apparatus. Eastbourne will arrange for cooking demonstrations.

A FURTHER stage in the gradual conversion to the automatic telephone system of the various exchanges in the Birmingham district took place a few days ago, when the Selly Oak and Woodgate exchanges were transferred to automatic working. The change-over was begun in March, 1931, and since then just over 10,000 lines have been brought under the automatic system, affecting the following exchanges:—Northern, Victoria, Harborne, Birchfield, Sheldon, Calthorpe, Smethwick, Solihull, King's Norton, Great Barr, Selly Oak and Woodgate. The change affects 733 subscribers in the case of the Selly Oak exchange and 171 in the Woodgate area. It is expected a further extension of automatic working will be entered upon in October in connection with the Castle Bromwich, Tipton, Blackheath, Broadwell, Halesowen, Stonecross, and Springfield exchanges. About the same time it is hoped also to convert the whole of the Wolverhampton area to automatic working.

# ELECTRIC BOILER INSTALLATIONS

(*For description see page 522.*)

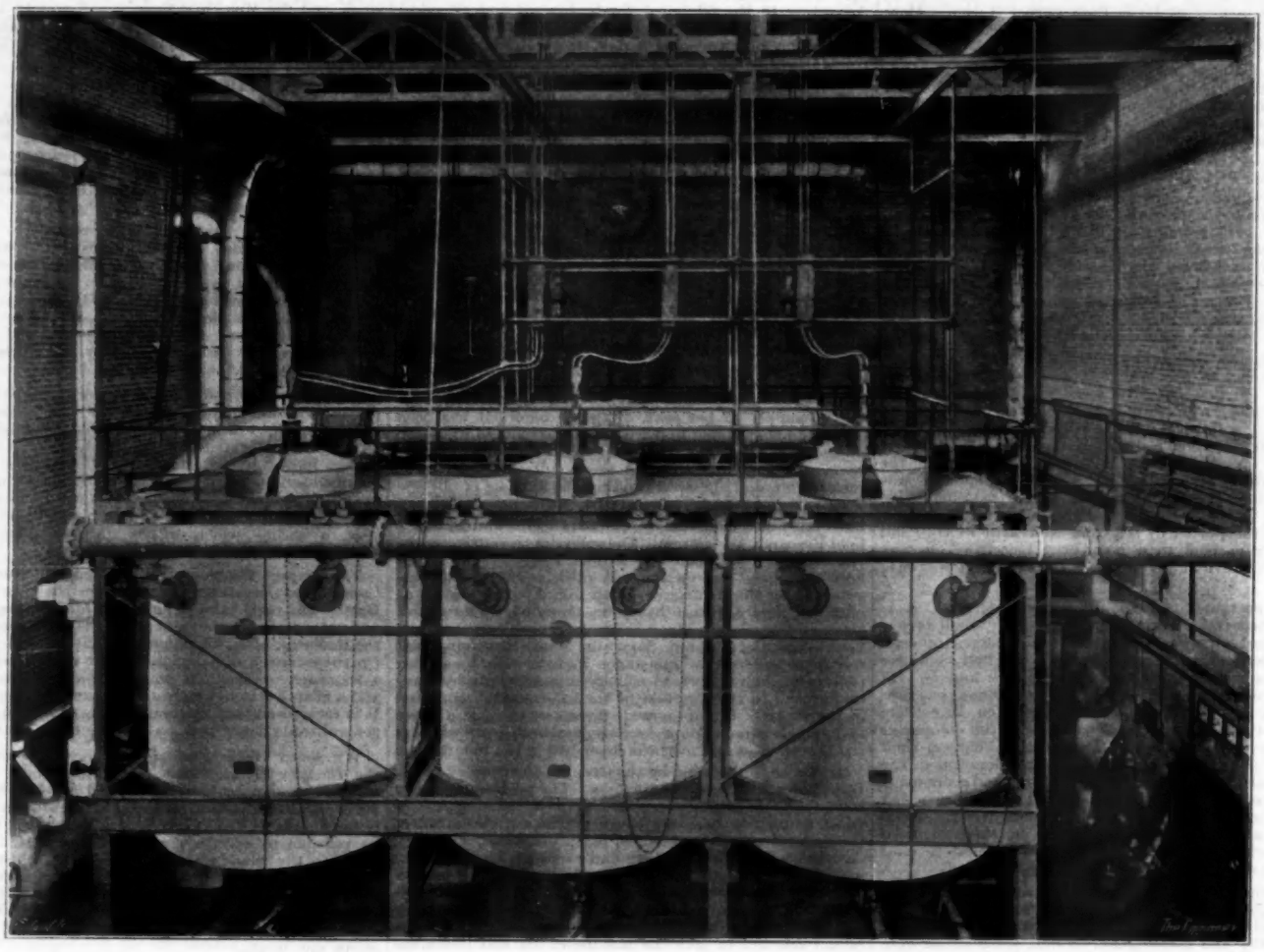

FIG. 3—64,000 kW THREE-TANK ELECTRIC BOILER INSTALLATION WORKING AT 13,200 VOLTS

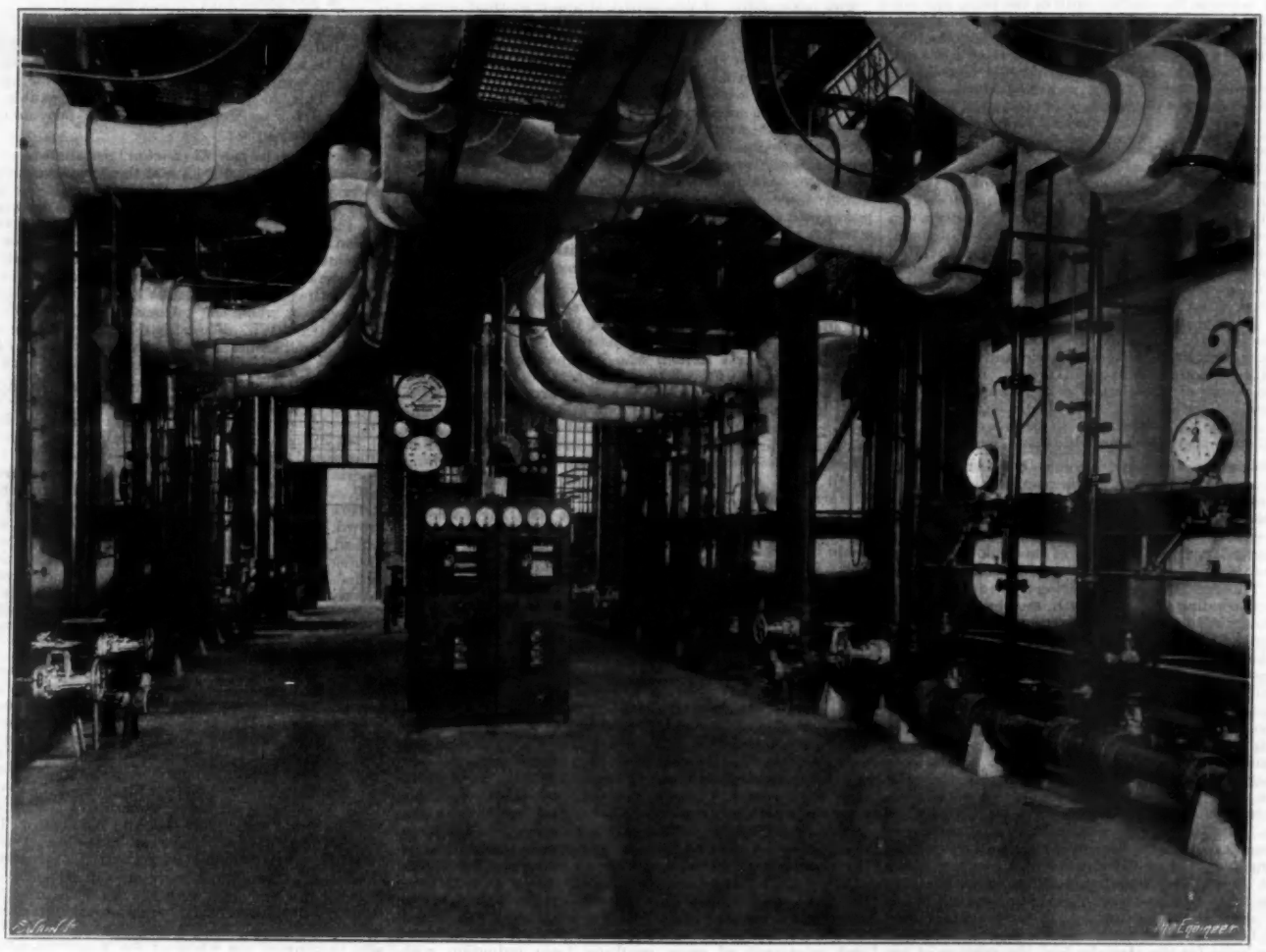

FIG. 4—147,000 kW THREE-TANK ELECTRIC BOILER INSTALLATION WORKING AT 6600 VOLTS

# The Engineer

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## INDUSTRY AND THE EMPIRE.

IN a few weeks the Empire Economic Conference will meet in Ottawa. At the meeting held in London last year it failed to accomplish anything of great moment. There was then a lively, but perhaps unwarranted, hope that it would lay the foundations of an Economic Union of all parts of the Empire. It did not do so. It was not able to reconcile conflicting interests; it was not able to convince the representatives that apparent sacrifices would, in the long run, turn out to be blessings. Will it be in an altered frame of mind in July next? Chastened by a year of trade depression which has brought every unit of the Empire to the brink of ruin, will it now succeed in resolving its differences? The issues turn rather on practice than on principles. The idea of an economic federation of the Empire has gained yearly in strength and even the spirit of nationalism which has spread throughout the world has not materially stayed its progress. Moreover, Great Britain has now come into line with all the nations of the Empire by the adoption of import duties. No one desires to see those duties used for the purpose of coercing the Dominions; no one desires that they should ever be exercised against the countries of the Empire as they are against foreign countries. But their economic effect in the conversations at Ottawa can scarcely fail to be important. They give to Great Britain a bargaining power which, without them, she lacked. Hitherto there has been little or no *quid pro quo* which she could offer to the Dominions for their concessions. That disability has been removed. The Dominions will be amongst the "most favoured" nations, and will receive consideration equivalent to those that they give. An ideal would be Free Trade within the Empire. It is, perhaps, too soon even to dream of it, but it is not too soon to do a great deal more than dream of an economic union between the Mother Country, the Dominions, and the Crown Colonies that would weld them into a veritable Federation of Nations.

The benefits that would accrue from economic co-operation within the Empire would affect the engineering industries at least as greatly as any others. Unfortunately, it is extremely difficult, owing to diversity of schedules, to present accurate figures of any selected industry; but, with the exception of Canada, it may be said that each of the Dominions purchases from the United Kingdom half, represented as pounds sterling, of the engineering products which it imports. Canada, owing to its own manufacturing interests and its proximity to the United States, takes far less; in fact, it purchases from America about ten times the value of engineering products that it takes from the United Kingdom. The value of British machinery sent to the major British Possessions may be taken as in the neighbourhood of twenty-five million pounds a year. That figure is not unsatisfactory, and the essential question for consideration is the disposal of the other moiety. Some of it is, of course, spent by one British Possession trading with another, but a large part of it, probably by far the greater part, goes to foreign countries—notably Belgium, Germany, and America. Since there can be no question that the Empire is in a position to supply practically all its own needs for engineering products, a very large sum—approaching twenty-five millions for machinery alone—could be retained within the Empire by an economic union. It is to be hoped that at the Ottawa Conference preliminary detailed statistics based on a common schedule will be presented. At present there is a great diversity in the returns owing to varying classification, varying values, and difference in financial years, &c. The figures we have given may therefore be questioned, but crude as they are, they do show, on a conservative estimate, the enormous importance of Empire engineering trade. Hence we commend to our readers careful consideration of the memorandum entitled "Industry and the Empire," which has just been issued by the Federation of British Industries. In that memorandum, from which we reprint some extracts on another page, we find this general statement:—"The nations of the British Empire are faced with this choice. If they determine to adopt strictly nationalistic economic policies, they will further restrict their own trade and international trade as well. If they combine to facilitate trade within the Empire, they will create a vast unit of world trade to their own benefit. The danger to the Empire lies in the fact that if the nations of the Empire decide, instead of co-operating, to stand alone, each one of them must eventually fall under the dominance of some foreign economic group, however attached they may be by sentiment to the Empire ideal." That statement condenses into a few words the whole case for an Empire Economic Union. The Dominions have in their hands the power to sanction the erection of a commercial federation of unexampled magnitude. They are not, as some pretend to think, asked to establish that federation for the benefit of Great Britain alone. It would operate for the benefit of each and all of them. That the Mother Country would share in the general prosperity is, naturally, her hope, but she believes that that desirable end can only be attained by means which will bring increased prosperity to every unit of the Empire. To quote once more from the F.B.I. memorandum. "The Federation regards the policy of 'Empire First' as paramount, not from sentimental or altruistic reasons, but from the point of view of practical self-interest. Every part of the Empire is suffering from grave economic difficulties, and it is only by joint action in the common interest that prosperity can be restored."

At no time in the history of the Empire have conditions been so propitious for the founding of an economic union. Not only will Great Britain for the first time meet the other nations at the Conference on level terms, but the period of adversity through which all the nations are passing makes all anxious to examine every project that opens a way to the return of prosperity. The prospects that something will at last be achieved are, therefore, brighter than they have ever been. But too much must not be expected. A scheme of such vast proportions could not be organised in a day or a month. Even the data on which it would have to be based are in confusion, and the first practical step would be their reduction to common denominators. All that it is reasonable to hope for is that at the July Conference in Ottawa the representatives will agree to the principle of an Empire Economic Union. If that be done the arrangement of the details can be left to the near future.

### Survival of the Consulting Engineer.

ONE marked characteristic of any highly developed social system is the differentiation of activities by the allocation of people to specific duties. In our modern communities, industries and professions become specialised. In medicine there are general practitioners, and specialist consultants in surgery and radiology. Of the specialist physician class, some are chiefly celebrated for experience in tropical diseases; others for the treatment of gout, rheumatism, and so forth. Of celebrated surgeons, some are concerned with operations on one part of the body, and some on other parts. In law, there is the differentiation in the duties of solicitors and barristers, and among barristers some practise in Chancery, others chiefly in the Criminal Courts, and yet others in the King's Bench. Law and medicine are, however, what may be called sheltered professions; no one who has not been "called" can plead in the High Court; again, only those who have passed the examinations of the Incorporated Law Society can style themselves solicitors. In medicine, only a registered medical practitioner can sign a death certificate, and it is a very serious offence against the law to practise in medicine or surgery alleging the qualifications without having passed prescribed examinations. Advertising for employment, personally soliciting employment, or paying commissions to those who influence the obtaining of employment is regarded as infamous.

In engineering there is a body of men who are independent of any manufacturing or contracting interests and who receive no remuneration for their work other than that from the clients who seek their advice or retain them to design and supervise the construction of engineering work. Many of them belong to the Association of Consulting Engineers. Their activities are then governed and described by a definition of that Association, which says:—". . . . advising the public on engineering matters, or to the designing and supervising the construction of engineering works and for such purposes provides his own office and staff, and is not directly or indirectly concerned or interested in commercial or manufacturing interests such as would tend to influence his exercise of independent professional judgment in the matters upon which he advises." The differentiation of function is, perhaps, not so rigid as that between the barrister and the solicitor, but the civil engineer who designs a dam or a large bridge does not concern himself with the design or lay-out, say, of a steam-driven power station. The taboos, major and minor, which rule all castes, rule equally in the case of the engineer who is carrying out purely advisory work, or is responsible for the planning and execution of large schemes. The rules which prohibit advertising, or soliciting work, the remuneration or employment of agents to obtain work, or payment for his services by any one but the clients employing him, are as rigid as in any other profession. A modified form of publicity is permissible. Just as the barrister may write a book on the law and leading cases covering any subject, or the doctor contribute a signed article to the Medical Press, or a paper to a medical society, so a consulting engineer may contribute papers for discussion or publication to institutions, and may, from time to time, write signed articles for the technical Press. In all castes, there are members who find the caste law irksome, whose wrath is provoked by the entry of the unqualified into the caste. For the consulting engineer there is no such shelter against such incursion as is to be found in other professions; it is open to any one to give himself this appellation, and having taken it, to be openly the paid official of a manufacturing firm, or—and this is far more dangerous—a secretly remunerated agent. The self-styled consulting engineer can practise as such without membership of any one of the chartered institutions. Very many of the public have been led astray by plausible men of a type that would be successful vendors of cheap-jack commodities in the market place. That is a minor cause of complaint. What is more serious is that consulting engineers in certain fields have to face a competition from sources which cannot be said to be unbiassed, a competition which is free to advertise and canvass without stint. We refer to that of manufacturing firms which offer complete schemes covering not only plant and equipment of their own make, but other equipment as well, asseverating their ability to do all that is necessary and to save the client consulting engineers' fees. Equally, in the past, machinery insurance companies have advertised their willingness and ability to advise factory owners; while, to-day, electric supply companies are quite ready to furnish specifications to the purchasers of electrical energy. In the past, too, certain architects are alleged to have

invited tenders for the electric lighting of buildings to wiring contractors' own specifications, without recourse to the consulting engineer. While this invasion of their sphere affects very seriously certain consultants, it leaves others whose work lies rather in the direction of dock, harbour, railway, reservoir or bridge work unaffected. These latter form, indeed, a closer preserve, sheltered almost to the extent of being almost a monopoly. To them the code "Thou shalt not advertise" is not irksome. Hence, whilst the right of the client to place work where he will and how he will and the right of manufacturers and contractors to accept contracts on their sole responsibility cannot be challenged, those who are unsheltered and yet feel constrained to frown upon individual advertising are wondering whether a collective advertisement, either by the Association or in conjunction with the chartered engineering institutions, would bring some alleviation of an admittedly difficult situation.

To the prospective client, advice which is at the same time impartial and competent, may be presumed to be of value, the more so when that advice is calculated to save money, either in regard to immediate outlay, or to operating cost or both. All will concede the probable competence of large manufacturing firms to advise and—up to a point—to prepare comprehensive schemes. But who can vouch for their dispassionate impartiality? In a world of many anomalies, the unsheltered and code-fettered British consultant has to endure the anomaly that it is legitimate to advertise any commodity in the world except brains trained for and devoted to certain work. The consulting engineer in other countries may brand this practice as insular and quixotic as he reflects that technical journals bearing his professional "card" circulate to a certain extent in the British Empire. But he recognises that the publicity allowed to him is perhaps one-tenth of one per cent. of that of the large manufacturing firms competing with him. As long as the consulting engineer had not to face the competition of manufacturing firms and contractors, he had no desire to advertise; but now that such firms are depriving him of his occupation, he is, perhaps not unnaturally, beginning to ask if the position is entirely equitable.

### British Machinery in France.

DURING the period that has elapsed since the holding of the Paris Fair last year, there has been a great change in the conditions of the machinery trade on the Continent, and the present Fair, which closes on May 18th, conveys a good idea of the way in which that change has been effected. A twelvemonth ago the machinery section was overwhelmed by an offensive of the German industry in the most approved style. German firms set out to impose their supremacy on foreign buyers, which they sought to accomplish by a costly demonstration of their products, and it is possible that the expense was justified by the hold which German machinery makers had secured on the French market, mainly as the result of their huge supplies on account of reparations. At the present Fair those efforts have faded out, though German machines for special purposes are to be seen in most departments. But despite their lack of prominence at the Fair, it is by no means certain that German machinery makers have relaxed their efforts in the French market, except so far as concerns the ordinary lines of machine tools which are almost entirely absent. One reason for this state of things may be the unsatisfactory financial situation of the German machinery industry generally, which necessitates severe retrenchment, and makers cannot afford to spend so much money on propaganda as they did last year. They are also deterred from such expenditure by the new French policy of import quotas for the protection of home industries, which, however, has not yet affected metal-working machinery, and the tendency of the country to restrict all imports may have influenced the Germans in abstaining from any costly effort to capture trade. If they are only allowed to import a certain quantity of machinery into France, they have no inducement to spend large sums of money in developing business beyond what is necessary for ordinary publicity arrangements. It may also be that the reduction of the German machinery industry through the closing of foreign markets, either by import quotas or by the economic depression which has reduced the purchasing power of some countries to zero, has altered the German outlook as regards foreign trade. That, at least, may be inferred from a proposal recently made in Germany that steps should be taken to prohibit the export of special machines that may help other countries to develop industries and create new ones in competition with German manufactures.

The readiness with which the French Government has fallen in with the views of home industrialists to impose import quotas for the protection of their interests is being taken advantage of by machine tool makers who hope to obtain similar assistance for the development of their industry. It is a fairly old industry, originating in the Maubeuge district where the first machine tools were made, but it is only since the war that it has grown in importance. At the present Fair the progress is most marked in the construction of the heavier classes of machines, but they are still all more or less of standard types, with improvements suggested largely by technical progress in other countries. At the Fair there are a few small grinding machines and one or two small gear cutters. These are an innovation, showing that makers aim at covering a wider range of machine tools which at present have to be imported, but it is extremely doubtful whether they can succeed in developing a business in competition with foreign firms which have the advantage of unrivalled experience and the benefit of a world market. Nevertheless, French makers are looking to help from quotas, and in doing so they may find themselves opposed by machinery users, who will not allow any exaggerated form of Protection that will have the effect of raising prices. After all, the construction of metal-working machine tools in France is not a great industry, and it is doubtful whether all the makers combined employ more than 5000 hands, while the number of men working machine tools throughout the country may be roughly computed at a million. National industries offer a very wide market for French makers, if they can supply it, and they are hoping that quotas will enable them to increase their share of the trade. On the other hand, the user cannot allow himself to be tied down to the purchase of machines of home manufacturers at high prices when there are foreign machines more suited to his purpose. If he is unable to buy the most efficient machines in order to lower production costs, he may be cut out of his market by foreign competition. So far as metal-working machine tools are concerned, it may be supposed that in the matter of import quotas the users of such machines will have the last word, though in the present state of affairs it is by no means certain that their interests will be fully considered.

The tentative efforts to determine some stable economic policy, mainly in the direction of enabling home industries to develop by limiting imports to what manufacturers cannot supply, has created a feeling of instability which has affected foreign exhibitors at the Paris Fair to a peculiar degree, even though there is nothing to show that the quota system will become a permanent institution in its present form. Rather is it fairly certain that some general international policy will be initiated eventually that will allow of normal trade relations amongst different countries, and until that takes place it is obviously to the interest of British manufacturers to keep their productions before French buyers. It will not do to hold aloof and allow foreign machinery users to believe, from what they see at their own Fairs and Exhibitions, that they can look for nothing better than what is produced in their respective countries. At the Fair there is only one British exhibit in the machine tool section, and that is devoted to the drilling machines of W. Asquith, Ltd. To say that it is the finest exhibit of its kind, makes it the more regrettable that other British machine tools are not represented. British products are, however, prominent in the sections devoted to oil engines and machinery for public works contractors. Whilst State departments will purchase nothing but French machinery, wherever that is possible, the contractor buys what is most suitable to his purpose, irrespective of nationality, and the activity in public works enterprise fully justifies the exhibits of road rollers by Aveling and Porter, Ltd., Ruston and Hornsby, Ltd., and Barford and Perkins, Ltd., as well as motor excavators and oil engines that are all the more conspicuous because they are not overshadowed by massive German exhibits, as they were last year. A thing to be remembered is that British machinery makers may improve their situation in the French market, when conditions are better, if they keep their hold upon it, and it is at times of trade depression and industrial evolution that it is desirable for the manufacturer to show his wares to the best advantage.

## Some Aspects of the Corrosion Problem.*

By ULICK RICHARDSON EVANS, M.A.

No. II. (*Conclusion*).†

### THE PROTECTION OF STRUCTURAL STEELWORK.

PROTECTIVE methods based on chemical water treatment may help the power engineer and the waterworks engineer. They can hardly help the structural engineer or the marine engineer. At the present day the covering of steelwork with some protective coat appears unavoidable, except where the steel is to be buried in concrete; in such cases, the alkalinity of the cement, assuming the absence of chloride and of stray electric currents from power circuits, usually inhibits attack upon the metal.

The covering commonly applied to steel consists of a number of paint coats. In painting, two quite different principles are employed. The paint may be used to exclude the corrosive influences, or, alternatively, to keep in good repair the natural invisible oxide film on the iron.

To exclude the corrosive influences would seem to be the obvious method of protecting metal. But tests have shown that few of the compositions commonly spread out on steel are completely impervious, or, even if they are originally impervious, they do not long remain so after exposure to the atmosphere in rainy weather. A film of dried linseed oil, for instance, appears to take up water much in the same way as gelatine does, and diffusion processes can occur through the film, as through any other jelly, although somewhat slowly. Furthermore, a paint film has weak spots in it like any other film. The danger of such weak spots is, however, considerably reduced by using several coats. The probability that a weak spot in the top coat shall be superimposed over a weak spot in the coat below it is small. The chance that they shall both fall over a weak spot in a third coat below is very small; and so on. If, in addition, the metal chosen is one which has few weak spots in its "natural" oxide skin, the chance of attack may become negligible.

The principle of film repair depends on using a basic or oxidising pigment in the lowest paint coat. Usually red lead is the pigment employed. Whether the red lead pigment acts rather in the same way as potassium chromate in water treatment, or whether some lead soap is formed in the oil phase and acts as an intermediary cannot yet be stated definitely. The latter explanation has many supporters.

In many atmospheres, a single coat of freshly mixed red lead in linseed oil has continued to give protection to steel long after similar specimens protected with single coats of other paints—commercial ready-mixed preparations as well as paints freshly mixed by the experimenters—have become rusty. This is probably due to the fact that the red lead or the lead soaps have a film-repairing action, and keep the iron "passive." But red lead coats are not mechanically strong, and it is best to cover a lower coat of red lead with other coats chosen for their good mechanical properties. Iron oxide paints appear quite suitable, and have the advantage of cheapness.

The chromates of lead and zinc have been used as corrosion inhibitors in the lowest coats of paints. In tests conducted in the Cambridge atmosphere a certain commercial lead chromate mixture gave exceptionally good results, as compared with the other paints tested, in summer, but worse results than all the others tested in winter. The reason is quite clear. Laboratory experiments had shown that steel can be kept in a solution of chromic acid or potassium chromate without rusting, owing to the film-repairing action, but that if chromic acid be added to dilute sulphuric acid, it acts as a depolariser—oxidising the hydrogen turned out from the acid—and thus causes the attack on iron to be quicker than in a solution containing sulphuric acid alone. Now it happens that the atmosphere in that part of Cambridge is pure in summer but quite acid in winter, probably owing to the products of combustion of the coal burnt in one of the colleges. Thus the pigment acts as an inhibitor of corrosion in summer and as a stimulator in winter. Even red lead appears capable of permitting corrosion in the presence of excess of acid. Thus, in the atmosphere of Westminster it was found that a single coat of red lead gave rather less protection than a single coat of iron oxide, although in the marine atmosphere of Selsey Bill and in the country atmosphere of Grantchester Meadows, the reverse was the case.

At the present time much excellent research into the subject of paints is being conducted, but on the whole more attention is being paid by paint investigators towards the stability of the paint substance itself than to the disease of corrosion which the paint is supposed to prevent. Apparently it is tacitly agreed in the paint industry that the failure of paint results from the attack of the elements—rain, air and sunlight—upon the paint itself, and that only when the paint has deteriorated in this way will the metal below be attacked in its turn. Consequently, very careful work is directed to the slow weathering

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changes of paint. Now there is no doubt that paint may fail in the way suggested, and, consequently, work of the type mentioned is fully to be encouraged. But there is another type of failure, which may sometimes occur far more quickly. Supposing that, in the first stages of exposure, a small amount of corrosion does—in spite of all precautions—occur below the paint. The amount may be so utterly trivial that the immediate damage to the metal could be neglected. Nevertheless, the damage produced by the corrosion product on the paint may be quite serious. For instance, if rust is produced below the paint, it occupies a volume vastly greater than the metal destroyed in producing it. The paint will be pushed away locally, its protective action will diminish and corrosion, once started, may under some conditions proceed apace. Or, again, if the water contains sodium chloride, the alkali formed by the cathodic reaction may, under some conditions, soften and loosen the paint so that it will peel off on the gentlest rubbing. The conditions for this "alkaline softening" do not often arise, since in general the alkali and iron salts quickly interact to give rust; but if the conditions are suitable, the softening may occur in a few days, long before the deterioration of the coats by the direct action of the weather on the dried oil could possibly have developed. It is quite clear, therefore, that the paint investigator cannot afford to neglect a knowledge of the disease of corrosion, and, further more, that he must bear in mind, not only the power of the paint to inhibit or retard corrosion changes, but also the power of the corrosion products to destroy the paint.

Nor must the possibility be overlooked that some of the ingredients occasionally introduced into paints may actually set up corrosion instead of preventing it. The alarming bursting of suspender buckles on Brooklyn Bridge has been attributed by American experts to the use of a paint based on fish oil which had been treated with sulphur. It would not be fair to condemn all sulphur-treated oils on account of this experience, but the matter requires to be borne in mind when considering the choice of ingredients for protective painting.

Hardly less important than a suitable choice of metal and paint is the condition of the surface to which the coat is to be applied. A set of outdoor tests was started a few years ago by Mr. S. C. Britton and myself, designed to study the effect of shutting in various substances, such as moisture, salt, mill scale, and old rust, alone or in combination, between the paint and the metal. Eight different paints were used, and five stations were selected to represent different types of atmosphere—country, urban, marine, "mixed," and "gasworks." Since nearly all the paints and all the types of outdoor atmosphere have led to the same conclusions, it is possible to generalise somewhat freely.

One of the most surprising results which emerged was the effect of a few grains of common salt shut in below the paint; single coats which normally protected steel for two years permitted the formation of rust within a few days when solid salt was present between coat and metal. Doubtless the salt drew in water through the paint film by osmotic pressure, and the paint was pushed upwards as a result. Salt outside the coat, as in the marine atmosphere of Selsey Bill, was very much less harmful.

The effect of condensed moisture on the metal at the time of painting—even in quantities so small as to be invisible—was also clearly brought out, thus confirming the observations of the German paint chemist Wolff. Specimens painted at dawn usually failed more quickly than corresponding specimens painted in the afternoon. This emphasises the wisdom of those engineers who have long been advising that contracts should contain a clause forbidding painting early in the day.

The presence of old rust below paint, whether with or without scale, was found to be injurious and led to early failure. Damp rust was worse than dry rust. Where it is absolutely necessary to paint over rust, the paint should contain more oil than would be used for covering a rust-free surface, the excess being needed to soak into the rust. For painting rusty specimens, iron oxide paints were found better than red lead.

The question of thick visible oxide scale below paint is a difficult one. Where it is continuous, impermeable, and adherent an oxide skin is doubtless a protection. The outer skin on cast iron—and that on cast steel—usually adds to the resistance, but the oxide scale on rolled steel is almost invariably broken in places. When an unpainted piece of rolled steel is immersed in water, electric currents pass between the scale-covered areas—as cathodes—and the places where the metal is exposed—as anodes. The total rate of attack is largely determined by the oxygen reaching the cathodic portions; the attack is concentrated on the small anodic area, and is therefore very intense, at least at first. But the nature of the scale depends largely on the composition of the steel and still more on the temperature of rolling. It is the most impervious and most tenacious scale which is likely to cause intense local attack or pitting at places where it is broken; with porous scale the attack will be more general, and may perhaps even stifle itself, whilst non-adherent scale will be undermined and will peel off, so that the attack no longer remains localised. The different behaviour of the scales obtained at different rolling temperatures is well brought out by certain data, not yet published, accumulated by the Joint Corrosion Committee of the Iron and Steel Institute and Federation of Iron and Steel Manufacturers, of which Dr. J. C. Hudson is the investigator. One cannot rule out the possibility that in a few years time it may be possible to conduct rolling under such conditions as to produce a scale which can with advantage be left in position when the steel is painted. Better still would be the production of a scale, which would peel off completely on gentle rubbing, so that the paint could be applied to the clean steel surface without added expense.

The outdoor experiments of Mr. S. C. Britton and myself suggest that, with the kinds of scale normally met with on steel at the present day, it is best to leave it in position when using certain paints and to remove it when using others. The results certainly suggest that the most permanent protection would be obtained by removing all scale before painting. But the removal of scale presents far more practical difficulty than the removal of old rust. Grinding is not to be considered for general engineering purposes. Scratch brushing does not remove the scale completely, although to the naked eye it may sometimes give the impression of doing so. Sand blasting is expensive and leaves a surface condition in which the air-formed skin is full of weak points, so that the steel is very susceptible to attack if condensation of moisture be permitted to occur. Pickling, commonly specified by the British Admiralty, is satisfactory if the drying is thorough; otherwise it may be dangerous. Another objection sometimes raised to pickling—namely, that traces of acid may be left on the metal—is being investigated at Cambridge. The results so far obtained suggest that the criticism is ill-founded, at least when pickling is conducted with sulphuric acid. Any traces of this acid left on the steel quickly attack the metal, giving iron sulphate, and little harm seems to occur provided that the desiccation before painting is made quite complete. Some authorities recommend that the acid pickle should be followed by an alkaline bath; this doubtless serves a useful purpose, since the alkali leaves the iron in a more or less passive condition, much less liable to the inception of corrosion before painting than the freshly pickled iron. But it must not be forgotten that alkali attacks most paint vehicles, and good washing after the alkali bath would seem to be called for.

In shipbuilding practice it has long been the custom to remove the scale by "weathering." In the old days the plates were exposed to rusting conditions for many months before paint was applied; the voluminous rust, largely formed below the scale, pushed it away from the metal, and a very moderate amount of cleaning allowed the paint to be applied to a surface which was essentially free from mill scale. In recent years it is generally agreed there has been a tendency for the weathering period to be shortened, and for this, and perhaps for other reasons, the paint is frequently applied over the scale. Considerable trouble has been experienced, both in British and Continental shipyards, owing to intense pitting along discontinuities or scratch lines in this scale. Many authorities, both on the Continent and in this country, attribute the common occurrence of pitting trouble in recent years to the shortened period of weathering. Incomplete weathering, which removes only a part of the scale, is admitted by almost everyone to be an unsatisfactory procedure. The weathering period should be long enough to loosen the scale over the whole surface. One German authority, M. P. Andreae, of Hamburg, considers that the scale on modern steel is more adherent than was formerly the case, and a longer period of weathering is needed to loosen it; since, in practice, a shorter time is allowed, the paint is frequently applied over the scale, which after a short period of service begins to flake off, bringing the paint with it.

A final verdict regarding the effect of scale under paint has still to be arrived at. There is fairly general agreement that, in the case of ships, complete descaling is desirable, but it does not follow that the same is true in the case of steel structures on land. Some of the researches now in hand may yield an answer to this question. Meanwhile, it is probable that engineers will be wise not to modify their existing practice on the point under discussion until the subject of the influence of scale is completely cleared up, except in those cases where the present procedure is clearly leading to trouble.

It is necessary to lay emphasis on the fact that the painting of steelwork which is to be immersed in water involves different principles to that of steel which is to be exposed to the atmosphere and which will only be wetted when rain falls or dew condenses. Since the formation of rust requires oxygen, it follows that in immersed corrosion, where the oxygen supply is limited, most of the rust is actually precipitated outside the paint, and, owing to the voluminous character of rust, a vast quantity may accumulate over the paint coat and yet the paint coat itself will be found firm and adherent; experiments have shown that this is the case; the large volume of rust really represents the corrosion of only a very small amount of metal. With steelwork exposed to the air, where oxygen is in excess, most of the rust is actually precipitated below the paint, and if the action is localised at breaks in the scale, the voluminous character of the rust causes the scale and paint to be pushed away from the metal, as already explained. Thus, in atmospheric corrosion a small destruction of iron does far more real damage to the paint than the destruction of the same amount of iron in immersed corrosion; when the paint has once been pushed away, the protection becomes poor and the rate of corrosion is accelerated.

For the engineer who esteems permanence, protection by painting must be looked upon as a not wholly satisfactory procedure; the coating is comparatively soft and liable to damage by abrasion. Moreover, the need for repainting at intervals is a serious drawback. The question of protection by metallic coats is one of some practical importance. Two classes of metallic covering are known—those in which the covering metal is cathodic to iron, and those in which it is anodic.

The cathodic coating materials include copper, nickel, tin and lead. These will only protect iron so long as the coating is continuous, so as to exclude the corrosion influences. If a break occurs, say, in a nickel coat, electrochemical action will be set up, the iron being the anode and suffering attack. Of the cathodic metals, lead is being seriously considered for large-scale work out of doors. The metal is somewhat soft and does not adhere well to iron. The first trouble can be overcome by alloying, and the second, to some extent, by preparing the iron ground with a thin coat of a second "bonding" metal; possibly other and cheaper methods of obtaining adhesion will be available before many years are past. It should perhaps be added that under some conditions lead may be found to be mildly anodic towards iron, but this will not affect the practical utility of the coating.

The anodic coating materials include zinc—with zinc-iron alloys—cadmium and aluminium—with aluminium-iron alloys. Here protection may be afforded even if the coating is porous or broken. Thus, a zinc coat which is quite porous or has been cut through locally, nevertheless protects steel against sodium chloride solution; for the zinc is here the anode of the couple, and the iron receives cathodic protection, provided the cathodic current density is high enough. But clearly the zinc is sacrificed in protecting the iron, and the protection will only continue as long as zinc remains. Even if the coat is continuous, the duration of protection is often limited, since these anodic metals are themselves attacked at an appreciable rate.

It is evident that there is no single method of protecting metal which is applicable to all conditions. A method which is successful for certain purposes fails lamentably for others. This only leads back to the statement made in the early part of the lecture that it is essential for the engineer—if he is to avoid serious trouble—to pay more attention to chemical principles. It will be far better that the engineer shall himself acquire sufficient chemical knowledge to guide his own choice, rather than he shall have to rely entirely on the advice of outside persons, whose knowledge of the engineering aspect of the matter is often imperfect, and whose attitude towards the decision may, in some cases, be not completely disinterested. And, on this note—the increasing importance of chemistry to the engineer of the present day—I would wish to close these remarks.

## BOOKS RECEIVED.

*Modern Practical Stairbuilding and Handrailing.* By George Ellis. London: B. T. Batsford, Ltd., 15, North Audley-street, W. 1. Price 30s. net.

*Wiring Systems.* By L. M. Waterhouse, A.M. Inst. C.E., M.I.E.E. London: Gee and Co. (Publishers), Ltd., 8, Kirby-street, E.C. 1. Price 5s. net.

*Hydraulics.* Fourth edition. By E. H. Lewitt, B.Sc., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

*The History of the Oil Engine.* By A. F. Evans, M.I.A.E., M.I. Mar. E. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E. 1. Price 25s. net.

*The Romance of London's Underground.* By W. J. Pissingham. London: Sampson Low, Marston and Co., Ltd., 100, Southwark-street, S.E. 1. Price 12s. 6d. net.

*Alternating-current Bridge Methods.* Third edition. By B. Hague, D.Sc., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

*The Engineering Equipment of Buildings.* By A. C. Pallot, B.Sc., &c., and H. Baines, C.B.E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

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*Photogrammetry: Collected Lectures and Essays.* Edited by O. von Gruber. Translated by G. T. McCaw, M.A., and F. A. Cazalet. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 30s. net.

*The Weathering of Natural Building Stones.* Building Research Special Report No. 18. By R. J. Schaffer, B.A., B.Sc. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 4s. net.

*Solutions to the Questions Set in Section A in the October, 1930, and April, 1931, Examination Papers of the Institution of Civil Engineers.* London: William Clowes and Sons, Ltd., 94, Jermyn-street, S.W. Price 3s. 6d. net.

# Institution of Mechanical Engineers.

SPRING MEETING IN LONDON.

ACCIDENTALLY or by intention, London's river and London's port very fittingly provided the keynote to the Spring Meeting of the Institution of Mechanical Engineers, which was held last week-end. It is true that some of the three hundred and odd members and ladies taking part in it visited Whipsnade, Croydon, and Chislehurst, and that to them, as a consequence, the meeting will be a memory of wild animals, aeroplanes, and caves. It cannot, however, be gainsaid that Mr. Asa Binns' paper presented on the afternoon of Friday, May 6th, definitely established the Thames and its docks as the main theme of the meeting. Mr. Binns, a member of Council and Chief Engineer to the Port of London Authority, gave us, principally with the aid of the cinematograph, an admirable impression of the vast and many-sided activities of that body and of the mechanical equipment by means of which its operations are conducted. On the following day a party of about 120 had an opportunity of making personal acquaintance with the Authority's work during a visit to the warehouses at London Dock and a sail down the river to Dagenham and back. The picture thus presented was rounded off on Sunday by an up-river trip to Windsor and Maidenhead.

The meeting was organised in order that those members who are not going to Canada in August might not be deprived of the opportunity for fore-gathering provided by the customary summer meeting. Whether it succeeded in attracting the support of provincial members to the desired degree there may be some doubt. It is, however, quite certain that it enabled many Londoners to learn much of interest and value concerning their own river and the work which goes on upon and about it.

THE PORT OF LONDON.

Some say that London was a trading centre before the Romans came to Britain. There is no doubt that it was one before they left, and that it rose to considerable eminence as the seaport of Verulam, the Roman capital. London owes its origin and growth to its river and, to an extent greater than is perhaps generally realised, its trade and commerce are still influenced by its geographical position. Were we required to-day to re-determine the sites of our principal seaports with a view to their meeting modern conditions in the best possible manner, it is doubtful if London would be included in our choice. With so much of our trade flowing to and from the west and south London might be deemed to be on the wrong side of our island and the Thames to run in the wrong direction. Some such thought doubtlessly lay in the minds of those who in 1802 planned a grandiose scheme to connect London with Portsmouth, of which only a few miles, still existing as the Grand Surrey Canal, were constructed. London became a centre of trade and communication with the countries of Northern Europe long before the discoveries of the fifteenth and sixteenth centuries turned men's visions to America and the rich markets of the East. It was excellently situated for its early purpose, and when times changed it succeeded in maintaining its status as a port by establishing itself as the centre to which produce from all parts of the world was brought for redistribution to the Continent. Much of that *entrepôt* trade still characterises its activities. In addition, its own population during the centuries has grown to such an extent that London has itself become one of the world's largest consuming centres for goods brought from overseas. Within a hundred miles of its docks one-third of the total population of England is to-day resident and one-third of the country's overseas trade passes through its port.

The history of the Port of London during the present century is well known. It may, however, be worth recalling the circumstances which led to the Port of London Authority being called into existence. The several docks which had been constructed on the banks of the Thames during the earlier years of the nineteenth century were owned and operated by separate companies. Competition for business led to the cutting of rates to such an extent that a century later the undertakings had become unsound financially. A time came when the companies had insufficient funds even to meet maintenance costs, let alone to carry out urgently needed extensions. In addition, the companies were hampered by various restrictive enactments, some of which dated from the reign of Queen Anne. A Royal Commission was appointed to inquire into the position, and as an outcome of its findings the Port of London Authority was established by Act of Parliament passed in 1908. At a cost of about £23,000,000 the new body purchased the undertakings of the old dock companies. It took over all the dock systems and in addition was given charge of the whole of the tidal portion of the Thames from Teddington Lock to the Maplin Sands and the Isle of Sheppey, a length of about 70 miles. The Authority is not a Government department nor is it subsidised in any way. It is controlled by a board of twenty-eight unpaid members appointed or elected for three-yearly terms by the Admiralty, the Board of Trade, the L.C.C., the City Corporation, Trinity House, the payers of port dues, wharf owners and owners of river craft. It derives its revenue solely from the dues and charges for the accommodation which it provides for vessels and goods and for the numerous and varied services which it renders to the users of its docks and warehouses.

When the Authority entered upon its duties on March 31st, 1909, it was confronted with a formidable task in repairing and bringing up to date the facilities of the port. Since that time it has expended in all about £20,000,000 on works of improvement. Notable additions which have been made in the Authority's period of control are the King George V. Dock adjoining the old Royal Albert Dock, the Quebec and Lavender Docks added to the Surrey Commercial Dock system, and a new landing stage and other improvements at Tilbury Docks. Just as important as any new construction has been the work done by the Authority on the improvement of the river channel. At a cost of over £2,000,000 some 47,000,000 tons of material have been dredged from the river bed, with the result that vessels drawing up to 37ft. of water now use the port, whereas in 1909 the ruling depth from the estuary to Gravesend was 25ft. at low water and decreased gradually all the way up to the city.

A partial but fascinating insight into some of the duties which the Authority performs, and a glimpse of some of the many and varied products which it is called upon to handle, were afforded to those who took part in the visit last Saturday morning to the warehouses at the London Dock. That dock and the adjoining St. Katharine Dock lie close to the Tower and the Tower Bridge and are the highest and about the oldest docks of the whole system. They are used by vessels engaged in the coasting, Continental, and Mediterranean trades, but it is in their warehouses rather than in their shipping that the visitor finds chief interest. In these warehouses are stored immense quantities of widely varied goods discharged at docks lower down the river and carried citywards by lighters or by road.

It is stated that in variety the goods accommodated in the London Dock warehouses surpass any similar collection in any other part of the world. Within a comparatively small compass are to be found stored or set out for the purpose of periodical sales products from every quarter of the globe. Here we saw quicksilver from the convict mines of Spain, agar-agar from Japan, nutmegs, mace and cinnamon from the Spice Isles, gums, essences and drugs. Shells, perfumes, wool, skins, wines, dried fruits and ivory are among the many other products which find their way to these warehouses in the heart of London.

The ivory show floor is a place to linger in. Here we saw thousands of elephant tusks set out and numbered after a recent sale. Pictures of slaughter among the elephants as ruthless as that which until recently was practised among the whales are dispelled by the information afforded by our guide that the very large majority of the tusks represent ivory found by native searchers and are not derived from animals killed in the hunt. The tusks, some of them weighing a hundredweight and more, are received from Africa and Asia and, London being the centre of the ivory trade, are re-distributed all over the world, some of them even going back to the countries whence they came for manufacture into bangles and other goods, to be sold in the native bazaars. Rhinoceros horns also come to the warehouse. These horns are not ivory, but are formed of a matted hairy substance, which, when heated, can be drawn out into sticks and other objects. Several splendid specimens of the tusks of the extinct mammoth were also shown to us. These tusks are very highly prized by ivory workers. Within recent years many thousands of them have been recovered from the frozen grounds of Northern Siberia and as many thousands more, it seems, still await excavation. It is believed that some 50,000 years ago vast herds of the animals were forced northwards in search of food and that, dying of exhaustion, they were immediately frozen. The very flesh of the animals was in some cases found uncorrupted and has been eaten as meat. In at least one instance the animal's stomach, on being opened, was found to contain the masticated grass of its last meal.

In a separate warehouse having a floor area exceeding 40 acres the arrangements made for dealing with the importations of wool were examined. It was London which built up the Australian wool trade, and it still holds a dominating position in the wool market. Last year the port handled the wool from 50 million fleeces, or 43 per cent. of the total importation into the United Kingdom. The handling of the bales, some of which weigh up to two hundredweights, is, or rather was, an arduous duty. It has recently been greatly facilitated by means of an electrically driven run-about bale stacking machine, the invention of one of Mr. Binns' assistant engineers.

From the top floor of the wool warehouse we descended to the gloomy, encrusted vaults below, in which wines, spirits, brandy, and rum are stored in bond. Accommodation is here provided for four million gallons in pipes, casks, and barrels. The brandy vaults alone cover an area of 4½ acres. With sawdust on the floor and an occasional gas jet the vaults are kept at an even temperature of about 60 deg. Here, too, was a place to linger in, to hear tales of sherry transhipped from vessel to vessel until it had been brought to perfection by a voyage round the world and to learn something about the other customs and practice of the wine shippers. But it was approaching midday when the excise officers would be locking up the vaults for the week-end. Barely had we time to note how to force a bung from a cask and to be introduced to the pipette-like "balincha" by which samples of the contents may be withdrawn.

If we are to be truthful concerning the voyage down the river which followed an excellent luncheon at the Authority's Club House, we must record the fact that London's "tradesmen's entrance" is about as unpicturesque a river as any in the kingdom, and that it conveys a general impression of squalid untidiness. There are no green margins flanked by towering hills, such as those which delight us on the Clyde. There are to-day, alas, no shipyards to attract the interest of the technically minded. Greenwich Palace, the one beauty of the river, is hideously flanked by the L.C.C. tramway generating station and is unfortunately near the South Metropolitan gasworks. A mean row of buildings is all that shows of the Royal Arsenal at Woolwich. Becton gasworks, Barking power station, and the northern and southern sewage outfalls are other features of the landscape which strike more than one of our senses. Private wharves, mostly unkempt in appearance, abound in the upper reaches, while lower down soap, linoleum, and other works sprawl along the banks. It is certainly not an engaging approach to the Empire's capital, and to-day it is made still less attractive by the economy being practised by shipowners in the matter of paint. On the whole, many visitors to our shores have reason to be grateful to the Port of London Authority for making it possible for them to land in comfort at Tilbury and to complete their journey by train.

It must be recorded that the new Ford works at Dagenham constitute an exception to our remarks. As seen from the river these buildings and their deep-water quay arouse interest by their tidy air of efficiency and decisiveness. It is interesting, too, to note that the only indication of the ownership and object of the works, the single word "Ford" on the stonework of the offices, attracts attention by its restraint and remains in the memory long after all the other river-side signs have been forgotten.

Concerning the docks and other property under the control of the Port of London Authority, it is difficult to write without being statistical. Whatever may be the case outside on the river, we pass into a different atmosphere when we lock-in to any of the docks. It is at once evident that we have entered a region of smooth, efficient operation, where everything is done and everything provided that will promote the interests of the users of the port. The Authority is not a money-making concern. It has no shareholders in the usual sense. It pays fixed rates of interest to holders of its stock and endeavours to arrange its rates and charges in such a way that its income will just equal its expenditure. If there is any balance remaining over it is made available for the improvement of the port. In the discussion on Mr. Binns' paper last Friday afternoon it was alleged that shipowners find London a dear port in comparison with most Continental ports. On that point it may be noted that the Authority claims that since 1925 it has made reductions in port charges which to-day are saving the users of the port approximately £1,000,000 per year. That fact, taken in conjunction with the knowledge of the condition of the docks when the Authority acquired them, speaks volumes for the progress effected since 1909. Notably must it have a direct connection with the developments made in the mechanical equipment of the docks, for after the civil engineer has constructed them it is the mechanical engineer who is left to run them efficiently. Of the money spent since 1909 on the development of the port over £4,000,000 has been expended on the provision of new or improved mechanical equipment. The total cost of all the mechanical equipment of the port as it exists to-day amounts to nearly £6,000,000. Included in that equipment are 1332 quay and other cranes, 220 lifts, 60 pairs of entrance lock and passage gates, 43 opening bridges, 145 miles of railway, 44 locomotives, 900 wagons and trucks, 7 dry docks, 5 dry dock pumping stations, 6 hydraulic pumping stations, 6 impounding stations, 10 cold stores, 4 electricity sub-stations, 6 fixed grain elevators, 17 floating grain elevators, 5 floating cranes, 19 tugs, 21 launches, 8 dredgers, and 14 wreck raising and mooring craft.

From Mr. Binns' paper we learn that the Authority now draws its supplies of electricity in bulk from outside sources, a marked change from the practice of the old dock companies, each of which had its own private generating plant. As a precaution against a local failure in the supply the Authority keeps in reserve "The Volta," an oil-fired steam-driven floating power station, which can in emergency be connected up to any group of docks to meet demands up to 720 kW.

Hydraulic power is supplied in part by the London Hydraulic Power Company and in part is generated by the Authority itself, principally by means of electrically driven pumps.

Since the s.s. "Strathleven" brought the first cargo of frozen mutton to this country in 1880 there has been a steady expansion in the cold storage facilities provided at London's docks. To-day the Authority's cold stores have a capacity of over 6½ million cubic feet, or sufficient for well over 1½

million carcases. In spite of the increased cost of fuel, stores, and labour, the working cost of the stores has risen from £3 0s. 6d. per 1000 cubic feet per year in 1914 to only £3 5s. in 1930.

Since high-water level in the river is about 3ft. 9in. lower at neap tides than at spring tides, the water level in the docks would tend to fall periodically to neap tide high-water level as a result of leakage and the docking of ships unless pumping were adopted. Twenty-five years ago there were impounding pumps at only three groups of docks. To-day all the docks are equipped with impounding plant except the St. Katharine Dock. The impounding pumps preserve the level in the docks at or above Trinity high-water level, and their use has saved the necessity of reconstruction and has prolonged the life of some of the older docks. All the impounding pumps are of the electrically driven centrifugal type.

Among the floating plant owned by the Authority the most outstanding item is perhaps the 150-ton floating crane known as "London Mammoth," which was built in 1927 at a cost of about £80,000. The pontoon of this crane is 200ft. long and over 77ft. in beam. At the minimum radius the top of the jib is 220ft. above the water level. The crane is equipped with twin screws, by which it can be propelled at about 5 knots. The height and radius commanded by the crane often result in its being used to deal with loads well below its capacity. During the two years ending on March 31st, 1931, the crane carried out 1152 lifts, of which only 52 exceeded 50 tons in weight.

The floating grain plant consists of seven bucket elevators and ten pneumatic elevators. Of the pneumatic elevators, the capacity of which ranges from 80 to 150 tons an hour, five were taken over from the old dock companies and five have been constructed to the Authority's requirements. Among the new machines a considerable diversity of practice is to be found. Two are driven by oil engines and have rotary air exhausters operated through speed-increasing gears. Two are oil engine driven with vertical reciprocating pumps. The fifth and most recent is steam driven and has vertical reciprocating pumps.

Many of the quay and warehouse cranes taken over from the old companies have been scrapped and replaced, but 30 cwt. is, as formerly, still the prevailing maximum lifting capacity. Although the number of hydraulic cranes is more than half the total, there has been a rapid increase during recent years in the number of electric cranes installed in the warehouses and on the quays. Most of the quay cranes installed since 1909 are of the level luffing type. The use of a modern quay crane for general cargo is found to cost from 4d. to 9d. per ton of cargo handled, including all working costs, capital charges, and crane drivers' wages.

Of the sixty pairs of lock gates, fourteen have been constructed within the past twenty-five years. There are twelve pairs of timber construction, the oldest of which have an age of 130 years. The first wrought iron gates were made in 1857 for the Victoria Dock entrance. When these gates were lifted for repairs in 1929 they were found to be in fair condition and to show little corrosion. All the gates installed since 1896 have been constructed of mild steel.

Omitting the war period, the imports of wheat and grain into the port has been slowly increasing and now amount to about 2¼ million tons a year, or about one-quarter of the total imports into the United Kingdom. Changes in the producing countries have, however, led to a reduction in the demand for storage room in public granaries, the waterside millers now taking more and more directly into their own stores. Much of the open floor storage accommodation for grain formerly in use has therefore been diverted to other purposes, and grain storage is now almost confined to the Millwall Central Granary and the silos at Victoria Dock. One of the transit silos at Victoria Dock was wrecked by the Silvertown explosion in January, 1917, and was reconstructed in reinforced concrete. During the discussion on Mr. Binns' paper Mr. Cecil Bentham had some criticism to offer on the Authority's attitude towards the grain trade. London, he said, had done nothing to encourage the storage of grain at its docks. It had in fact lost much of this business to other ports which had laid themselves out for it. In particular it had lost the custom of those shippers who took in cargoes without definite knowledge of their destination and who frequently required to store the grain until they could find a good market for it.

Of the Tilbury Landing Stage we need hardy speak on this occasion, for it was fully described and illustrated in our issue of July 11th, 1930. Nor will space permit us to mention many other details of interest connected with the mechanical equipment of London's docks. Those readers who desire to learn more cannot do better than study Mr. Binns' excellent paper in the original.

## SYDNEY HARBOUR BRIDGE.

In response to numerous requests we have decided to reprint in a collected form the seven articles descriptive of the design and erection of Sydney Harbour Bridge, which appeared in our issues dated from March 18th to April 29th.

## Industry and the Empire.*

In July, 1932, the Empire Economic Conference reassembles at Ottawa. The Federation desires to stress—even more emphatically than before—the paramount need for a policy of Empire economic co-operation broadly conceived and actively prosecuted.

No part of the British Empire is self-contained. Each is dependent upon overseas markets. To Great Britain her export trade in manufactured goods is a vital necessity on which the livelihood of her people depends. Similarly, the Dominions, India, and the Crown Colonies must have as a condition of their continued progress a substantial export trade in agricultural and mineral products.

The nations of the British Empire are faced with this choice. If they determine to adopt strictly nationalistic economic policies, they will further restrict their own trade and international trade as well. If they combine to facilitate trade within the Empire, they will create a vast unit of world trade to their own benefit. The danger to the Empire lies in the fact that if the nations of the Empire decide, instead of co-operating, to stand alone, each one of them must eventually fall under the dominance of some foreign economic group, however attached they may be by sentiment to the Empire ideal.

The extent of the prosperity we could create for ourselves is clear from the following facts. The Empire consists of 13,355,000 square miles—26 per cent. of the world's surface. Its population is 450,000,000—20 per cent. of the world's total. For the year 1929 it has been estimated that the trade of the British Empire represented 28·2 per cent. of total world trade. While the recent depression has reduced Empire purchasing power, the Empire still contains all the potentialities for a rapid increase of both wealth and trade. In 1900 the value of the combined overseas trade of Canada, Australia, New Zealand, and South Africa was approximately £230 million; in 1911, £460 million; and in 1929, £1050 million. The expansion of the trade of the Colonial Empire has been equally marked. In 1913 the total overseas trade of the Crown Colonies and Protectorates was £170 million; and in 1929, £430 million—mandated territories excluded. Even if allowance is made for the rise in prices which has occurred between these dates, these figures obviously record a large increase in trade.

The Federation regards the policy of "Empire First" as paramount, not from sentimental or altruistic reasons, but from the point of view of practical self-interest. Every part of the Empire is suffering from grave economic difficulties, and it is only by joint action in the common interest that prosperity can be restored. Disaster will follow if the various Empire delegations go to Ottawa simply as sellers intent on a bargain. The Federation believes that the advantages to be derived from Empire economic co-operation are so far-reaching that each part of the Empire, by contributing towards the prosperity of the whole, must of necessity contribute towards its own best interests. Anxious as each delegation will naturally and properly be to safeguard the interests of its own producers, the best results can only be achieved if, in place of a bargaining spirit, there is an atmosphere of mutual accommodation and readiness on the part of all to make the maximum possible contribution towards conjoint Empire interests. The Federation of British Industries suggests that His Majesty's Government should decide what advantages it can offer in the market of the United Kingdom to Dominion producers, which must clearly in the main be in respect of primary products. The Federation trusts that the negotiations at Ottawa will enable these advantages to be extended to all Dominions equally. It is obvious, however, that if Empire trade policy is to be based upon the principle of mutual benefit, the continuance and development of such advantages in the market of the United Kingdom must depend upon the adoption of a similar policy by individual Dominions overseas.

The spirit of Empire co-operation depends upon whether the various delegations are agreed upon the basic principles underlying such a policy and the national benefits to be derived from mutual help. The first principle is recognition by each nation of the Empire of the unfettered freedom of every other Empire nation to promote its own domestic development.

The second principle is that the fostering of uneconomic production is unsound. Attempts to foster industries for which the conditions of a country are unsuited or for which the stage of its general economic development renders it unready, can only result in national impoverishment, and, if persisted in, must lead to disaster—material, social, and economic.

The third principle is the ultimate importance of agriculture to the welfare of every constituent part of the British Empire.

The foregoing three points must form the basis of an Empire preferential policy. Preference must, if it is to help in the development of Empire prosperity, be preference not in name only. It must provide effective protection against foreign competition.

The Federation acknowledges that any preference granted to Great Britain by the Dominions can only be justified if British manufacturers meet the demands of the Dominions by supplying what the Dominions want at the right prices, properly delivered, and supplemented by adequate services to purchasers.

Preference should be restricted to genuine Empire products, and should not be afforded to manufactures of predominantly foreign origin which are merely assembled or finished in the Empire. This is a matter in regard to which practice varies. Uniformity is desirable, since the many and varied regulations in force are a great hindrance to the easy conduct of trade. The Federation recommends that the Empire Conference should initiate a study of this question, with a view to obtaining, in consultation with the industries affected, an agreed Empire formula respecting the Empire content of labour and/or material necessary to qualify for preference. It is recognised that different percentages may be necessary in the case of different industries. The importance of this aspect of the question cannot be exaggerated.

The purpose of a conference on complementary production between the manufacturers in a particular industry in Great Britain and in a given Dominion would be to explore the feasibility of an arrangement whereby the production of certain goods should be recognised as being the province of the Dominion manufacturer, whereas others would be regarded as better left to the United Kingdom manufacturer.

To avoid any possible misunderstanding of the attitude of British industry towards the policy of complementary production, the Federation desires to make it clear that any agreement that might be arrived at between British and Dominion industries should be subject to periodic revision. Complementary production means the concentration of Dominion industrial effort upon those branches of each industry for which the conditions are suitable. It allows also for an orderly progress in which Dominion industries steadily increase the range of their products. It may be contended that such a plan would restrict United Kingdom industry to an ever-declining share of Empire trade. In industry new processes and new forms of demand are, however, constantly appearing. The utilisation of these new processes and the satisfaction of these new demands require, in the early years of their development, a highly elaborated industrial system and a market of world-wide dimensions. British manufacturers would therefore find a constant and growing market within the Empire, and, although the type of their exports to the Empire might change, their volume would increase.

It is obvious that agreements on these lines require the support of Governments, if concrete results are to be obtained. Fortunately, the proceedings of the Empire Conference of 1930 show that the Governments of the Empire are already sympathetically inclined towards this policy of complementary production. If fruitful conferences are to be held between those engaged in industry, then the Governments must be prepared to adapt their policy in such ways as first to facilitate and then to implement such agreements. The Federation trusts that Empire Governments will continue their active interest in this policy. Empire Governments would naturally protect those products suitable for domestic production. They would arrange for effective preference on the other lines, while maintaining sufficiently high rates under the general tariff to ensure that the preference granted was real and not illusory.

The Federation believes that the policy of complementary production would result in a greater degree of tariff stability within the Empire. The relative position of Empire industries would be adjusted to a large extent by mutual agreement.

In its report prior to the Empire Conference of 1930, issued in February of that year, the Federation urged the necessity for the adoption of some method whereby the countries of the Empire could maintain a constant survey of Empire economic problems, and consult jointly as to economic co-operation. The Federation desires again to suggest that a true Empire organisation should be set up, representative of all parts of the Empire upon an equal basis, and engaged upon the study and correlation of information and not upon executive action. The main activities of such an organisation would be:—

(1) A general and continuing study of Empire economic questions, especially with regard to rationalised Empire production, where obviously the existence of a "clearing house" of information would be advantageous.

(2) The preliminary study of questions to be dealt with at Empire Economic Conferences.

(3) A careful record of the progress made between Conferences to put into effect the decisions arrived at by the Conferences.

As a result of the creation of such a new organisation, some amalgamation might be possible of the various official bodies which at present are charged with the duty of considering different aspects of the Empire economic problem.

If the principle of constant and close economic consultation is accepted, it is essential that such consultation should take place upon a sound foundation of knowledge. For this purpose, adequate and comparable Empire statistics are needed.

The Federation believes that the policy of this country and of every Empire country can with the greatest advantage be based, in the first place, upon the development of inter-Empire trade. It recognises to the full, however, the importance of trade with the rest of the world, and it expresses the hope that once an inter-Empire trade agreement has been arrived at, it will be possible to make commercial agreements with such foreign countries as are prepared to negotiate upon a basis of mutual advantage.

* Extracts from a Memorandum issued by the Federation of British Industries, Tothill-street, Westminster.

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The protection of American export trade and the prevention of dumping of foreign-made products can be more specifically handled, says an editorial in *The Iron Age*. The Hawley-Smoot act has sufficient teeth to provide a deterrent to nations now subjecting our products to a maze of embargoes, quotas, licences, evasive custom specifications, and other trade harassing schemes. As much as it is hoped that it will not be necessary to use these teeth, there are points beyond which patience ceases to be a virtue and the nation which relies upon it becomes a "goat."

Middlesbrough is assured of an adequate gas supply for the next fifteen years, and soon it may be cheaper. This fact was revealed at a recent meeting of Middlesbrough Town Council, when Alderman S. A. Sadler, Chairman of the Gas and Electricity Committee, announced that his Committee had approved an agreement with Dorman, Long and Co. for the supply of coke oven gas for the next fifteen years. "We shall not have to spend money we anticipated spending," he said, "and to save the rates a further burden, I hope the time will not be far distant when, as a result of this bargain with Dorman, Long and Co., I can come to you with a further reduction in the price of gas." At present Middlesbrough's gas—supplied entirely from the coke ovens of Dorman, Long and Co.—is the cheapest in the country.

# The Christie Two-Stroke Gas Displacement Pump.

WE recently inspected at the Newbury works of Plenty Still Oil Engines, Ltd., a two-stroke gas displacement pump, invented and patented by Mr. S. P. Christie, of 13, Innismore-gardens, S.W. 7, and built to his order and design by Marcus Hodges and Sons, Ltd.—late Hodges Brothers—of Haven-road, Exeter. After undergoing successful tests at the Exeter works, the pump was removed to Newbury, so as to be nearer to London for demonstration purposes.

### THE CYCLE.

The accompanying illustrations show that the demonstration plant is very simple in construction, the pump

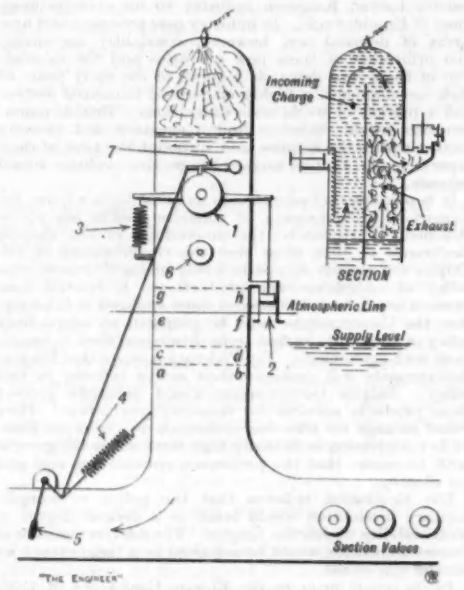



FIG. 1

body being formed of practically straight castings, while the play pipe is of standard Mannesmann steel tubing, having screwed flanges and a thickness of ⅜in. The internal diameter of both the pump and play pipe is 12in.

The principle upon which this pump operates is that devised by Mr. H. A. Humphrey, and realised in the great plant at Chingford, but with the difference that a two-stroke cycle is used in place of a four. Mr. Christie's pump is shown diagrammatically in Fig. 1, at the moment

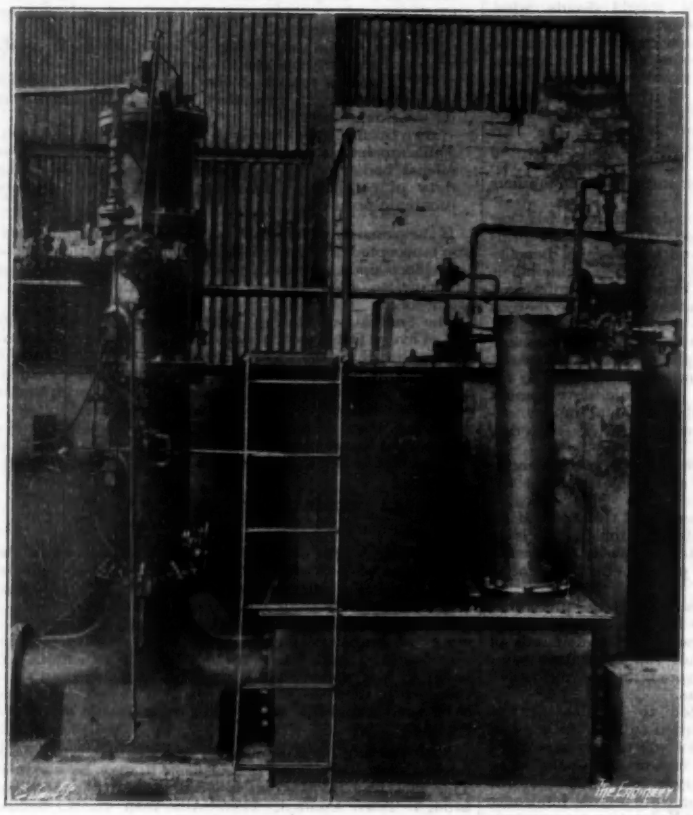


FIG. 2—EXPERIMENTAL PLANT AT NEWBURY

when ignition of a compressed charge has just taken place. The effect of the explosion is to drive the water downwards and in the direction of the arrow into the play pipe. The momentum of the water in the latter carries the surface of the water in the pump body below the atmospheric line *e f* down to *a b*, thus creating a partial vacuum in the chamber. In consequence of this reduction of pressure, a fresh supply of water enters through the suction valves, some of it being carried forward by its inertia to the delivery and some rising in the pump body to about the level *g h*. This rise is, however, only momentary, the continued movement of the water in the play pipe causing the level to fall to *e f*.

In the mouth of the play pipe there is suspended a paddle 5, which is controlled by the spring 4 and coupled to the pawl 7. When the velocity of the delivery has fallen to a certain amount, the spring 4 overcomes the pressure upon 5, and the pawl is lifted, releasing the cam 1, which is attached to the spindle of a rotary admission valve. A new charge under a slight pressure, enters through this

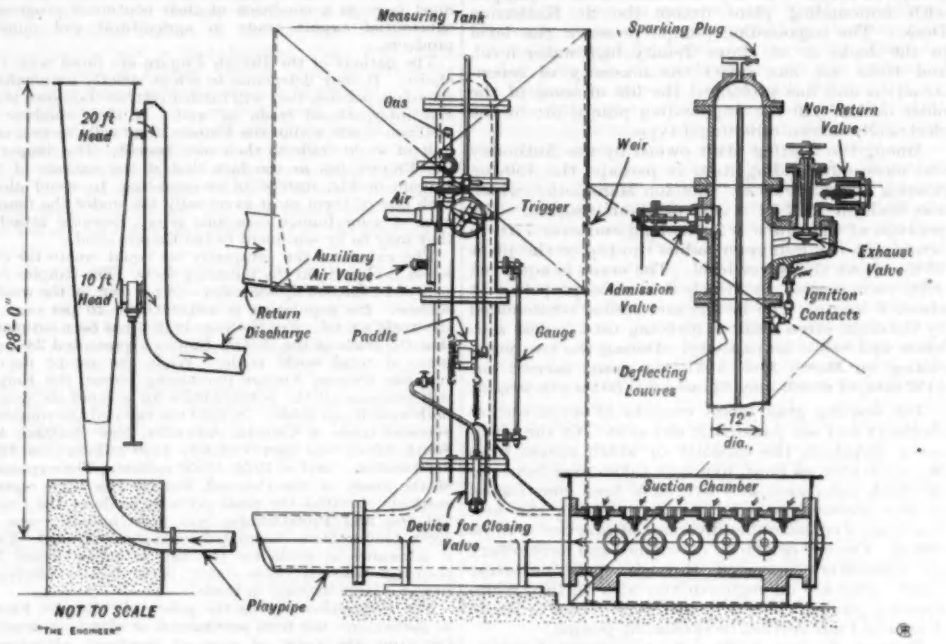



FIG. 3—TWO-CYCLE GAS DISPLACEMENT PUMP

valve and, as shown in the section, expels the burnt gases through the exhaust valve, which has opened automatically. The water returning from the play pipe rises, helping to displace the burnt gases, and, after drowning the exhaust valve, compresses the new charge in readiness for the next ignition stroke.

Under some conditions of operation, the degree of vacuum created on the downstroke of the pump may be so high and its incidence so rapid that there would be a danger of the pump filling up on the return or upstroke, in such a way that there would be no time for its entry and no space left for the incoming charge. In order to obviate such a condition, a little auxiliary air is admitted through the valve 6, which has a vacuum breaking effect, and is also of service in cooling the combustion head, which, of course, in the two-stroke pump attains a somewhat higher temperature than is usual with the four-stroke pump.

It is claimed by Mr. Christie that since the volume discharged on one stroke is the measure of the volume taken in during the preceding cycle, other factors being equal, the two-stroke system enables the suction energy to be practically completely utilised in drawing in water, whereas in the four-stroke pump it has to draw in air on the first outstroke and gas on the second outstroke, the water entering very largely under gravity. It follows therefore that the delivery of the two-stroke pump per working stroke compares favourably with that of the four-stroke pump, quite apart from the quicker cycle, while the power expended in the auxiliary blowers necessary for the introduction of the charge is largely recovered in hydraulic work. Again, it is claimed by the inventor that the final charge in the case of a four-stroke pump is necessarily composed of air remaining from the residual cushion intermixed with some burnt products to which a charge of rich mixture is added on the second outstroke of the pump. Under these conditions homogeneity of charge is very difficult to attain, whereas in this two-stroke pump the constituents are very thoroughly intermixed as they pass through the same inlet valve. Thus an almost pure charge is compressed, at the cost of some little exhaust port losses, resulting from the sweeping out of the old charge, making it thereby certain that the power of the two-stroke pump is practically double that of the four-stroke pump of the same size, if not more.

As originally planned, the vertical combustion chamber was connected at one of its lower ends to a 60ft. long, 12in. bore, horizontal play pipe, which terminated in a 20ft. by 5ft. diameter vessel. The suction end of the pipe was equipped with a valve box similar to that shown in Fig. 3, with sixteen 5in. diameter valves. A 90 deg. V notch was used for measuring the amount of water pumped. Test figures which have been submitted to us show that various trials were run during which the pump operated satisfactorily at heads from 12ft. up to 30ft., with this length of play pipe. At 22ft. head when making about twenty-six firing strokes per minute, it delivered 1400 gallons of water per minute and used 5 cubic feet of 475 B.Th.U. Exeter town gas. The maximum efficiency obtained during these tests was 14·7 per cent. At Newbury, however—see Fig. 2—the space available in the works did not allow without considerable expense quite such a generous lay-out, and a vertical rising main was therefore utilised instead of the vessel on the end of the play pipe. The suction tank arrangements, too, were somewhat cramped, and a restricted flow to the suction valves reduced the efficiency of working. Nevertheless, it was possible to carry out some interesting experiments at some of which we were present, utilising an alternative arrangement of inlet control gear for the air and gas valve, which, as shown in Fig. 3, was operated by a paddle placed within the lower third of the vertical combustion chamber. As our drawing indicates, the rising main at the end of the play pipe permitted various working heads from 10ft. to 20ft., and at the time of our inspection the pump was working very regularly and silently, with an output of 1000 gallons per minute against a 20ft. head, the firing strokes, as counted from the beats, being twenty per minute.

The flow of gases within the pump is guided by means of a central diaphragm, and, in addition to this, the inlet valve is furnished with deflecting louvres in front of the valve orifice and below it, the object of this fitting being to direct the entering charge in a downward direction. Experiments with this valve arrangement have shown considerable saving in the matter of exhaust port losses, and

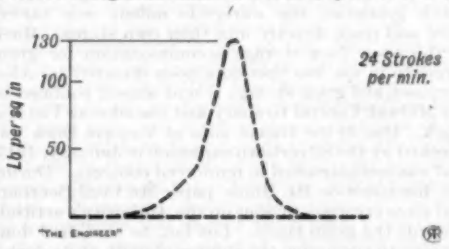


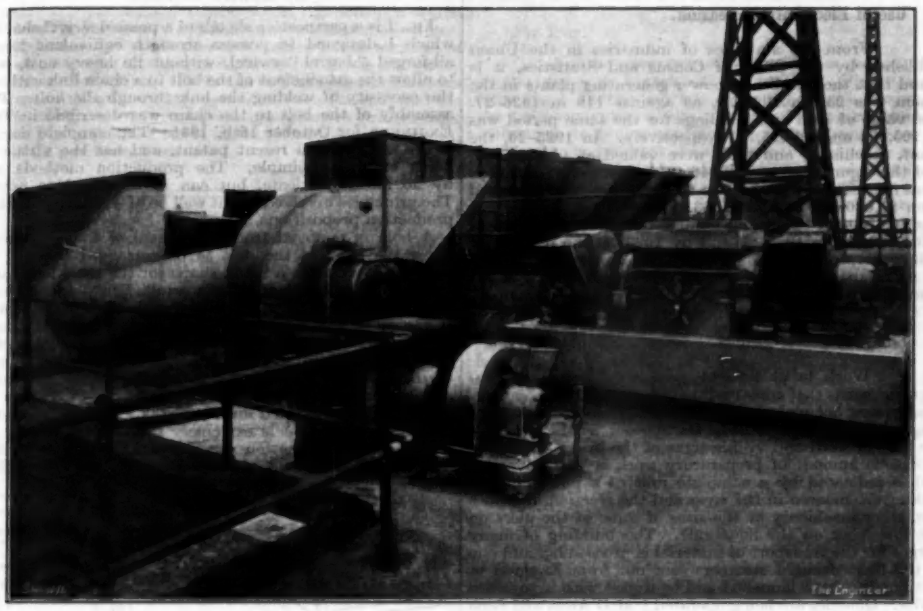

FIG. 4—TYPICAL INDICATOR CARD

have also prevented undue diffusion of the entering charge with the products before they are expelled by the action of the rising water through the exhaust valve. A typical indicator card is reproduced in Fig. 4, taken with the pump working at twenty-four strokes per minute.

It may be stated that the power required for compressing separately the gas and air into containers by means of small motor-driven Reavell compressors, has enabled the horse-power for a representative plant to be calculated at about 5 to 6 per cent. of the total water horse-power.

The admission valve is of the semi-rotary ported type, and works on a disc seating similarly ported, but provided with a non-return valve on its inner face, which prevents the internal pressure from reaching the outer slide valve face. By the admission of a little water to the housing, it has been found possible to keep the valve adequately lubricated and also sealed during the suction at that period when it is important that no combustible charge should enter the cylinder. No difficulties, we are informed, have been experienced with pre-ignition and the regulation of mixture strength, owing to the tightness of the valve and its method of operation. This inlet valve is positively shut against spring pressure—as shown in Fig. 3—by means of a small piston moved downwards by the compression pressure. According to the load under which the pump is called upon to work, the paddle may be

## B.B.C. STUDIO VENTILATING PLANT



placed in the lower part of the pump chamber or in the play pipe. Should the pump be required to lift water from a lower level, advantage may be taken of the surging in the pump chamber by placing the paddle in that chamber. In this position it trips the inlet valve on the first upward surge of the water, and thereby allows advantage to be taken of the full vacuum before any elastic fluid enters the pump. This method of working has been found to be specially suitable for suction lifts with heavy discharges, which require low compression pressures and very little air. If, however, the paddle be placed in the play pipe—which was done during the Exeter tests previously referred to—the inlet valve is then held in the closed position during the major part of the outstroke, and it becomes necessary to admit some scavenge or vacuum-breaking air through the auxiliary air valve, so that the level of water within the pump falls sufficiently to give the necessary clearance for the back stroke, with good compression and sufficient time for the entry of the charge. This method of working has been found more suitable for pumps working with a high lift. The experiments made indicate that possibly a combination of these two methods of control might give still better results, thus the admission of the charge might be timed by the play pipe paddle and the scavenge air controlled by the pump chamber paddle, which is actuated by the rebound on the suction stroke after maximum vacuum has been attained. The many tests carried out with the pump described showed that these seemingly complex movements could quite well be controlled by adjusting the spring tension on the admission valve timing gear, while the pump was running.

## Broadcasting House.

On Tuesday last we were afforded an opportunity of inspecting the new headquarters of the British Broadcasting Corporation, situated at the corner of Portland-place and Langham-street, and known as Broadcasting House. Although apart from the experimental ultra-short wave transmitter mentioned in our issue of September 4th, 1931, none of the equipment of the building is designed to transmit speech and music without wires, there is much of technical interest.

Broadcasting House is really a building within a building, for the offices are arranged round the outside of a large central brick-built tower, which contains extensive studio accommodation. Thus, while the offices have the full advantage of daylight, they act as sound insulators for the studios which they encase. Accommodation is provided for a staff of 750 persons, whilst the tower contains no fewer than twenty-two studios, built in self-contained suites. There are three floors below and eight above the street level, and a special feature of the building is its elaborate system of ventilation. As the studio tower is entirely encased by the offices, and is built to exclude all noise, it has to be provided throughout with artificial ventilation and lighting, and in order that the artists may work under the most favourable conditions, the air is conditioned before it is circulated through the rooms. When the temperature in a studio tends to rise, an automatic device introduces a supply of cooler air, which in the conditioning process is drawn over water sprays which remove all particles of dust and soot, the humidity and temperature of the air supplied to the various studios being adjustable in accordance with outside conditions. From the various conditioning plants in the sub-basement the air is fed to the studios, listening rooms, artists' waiting-rooms, green room, &c., by metal ducts, designed to prevent the transmission of sound. In many cases the ducts had to be lengthened in order to secure the requisite sound insulation. The air is extracted from the studios by fans situated on the roof, as shown in the accompanying illustration, which also shows the water coolers which operate in conjunction with the refrigerator in the basement for the provision of sufficient cooling for the studio air in hot weather.

As the offices are not enclosed, it is unnecessary to supply conditioned air to them, but in the winter they will be heated by hot water radiators, supplied by oil-fired boilers, which also provide the hot water required for domestic purposes. The contract for the air-conditioning, ventilation, and heating and hot water systems was awarded to the Carrier Engineering Company. The building is supplied with three-phase current by the St. Marylebone Borough Council's electricity department, but a secondary lighting supply can be derived from a storage battery in the basement. Should the public supply fail, the emergency lighting, which is permanently switched on during the hours of darkness, in addition to the regular lighting, will provide sufficient illumination for the continuation of the performance, whilst if the breakdown should be of long duration, a 100-kW oil engine set will deal with all the essential lighting and ventilation load. The anticipated peak load demanded by all the electrical equipment when the building is in full use will be in the neighbourhood of 500 kW.

As we have said, the new building contains no fewer than twenty-two studios, and many may wonder why so many are required, especially when it is remembered that up to 1924 there were only two at Savoy-hill. In the first place, it must not be forgotten that performances have to be rehearsed, and that the time needed for a rehearsal is usually more than three times greater than that needed for the performance itself. Some programmes, moreover, such as plays, require as many as six studios in simultaneous use, and certain types of transmissions require widely different studio acoustics, in order to obtain the best possible results. When all these considerations are taken into account, the need for so many studios is readily understood, but it must not be supposed that they are all of the same size. They vary, in fact, from small "talks" studios to the main concert hall, which has a volume of 125,000 cubic feet, and is capable of seating an audience of 750 people, in addition to a full symphony orchestra.

Each suite of studios has its own artists' waiting-room, so that artists can be called to the microphone with minimum delay. Each studio has a separate sound-insulated listening room, provided in most cases with glass windows through which the performers in the studio can be seen and the rooms are acoustically treated to resemble the listener's sitting-rooms, so that those responsible for the general standard of transmission can hear the performance on loud speakers under the same conditions as the public. An announcing room associated with each studio avoids the necessity for making announcements in front of the artists.

One of the most interesting sections of Broadcasting House is the control room, which is divided into two parts—rehearsal and transmission sections. The equipment consists essentially of all the amplifiers and auxiliary equipment required in the chain of transmission between any studio or outside broadcast point and the lines feeding the transmitters. The room also contains the control positions or desks from which any studio can be brought into circuit, and the outgoing transmission can be checked. The transmission section is equipped with six control desks, and with supervisory and simultaneous broadcasting desks. Along the length of this transmission section of the room are racks of amplifiers, each group of amplifiers fulfilling a definite function in the chain of transmission between the studios and the transmitters. Adequate stand-by equipment has been provided, with means for bringing it into use in the event of apparatus failing during the course of a transmission, and relays enable the complete chain of transmission between any studio and any outgoing line to be brought into action in the shortest possible time.

The room is also equipped with signalling devices to show the approximate positions of faults and much subsidiary equipment, such as wireless check receivers, land line testing equipment, amplifiers for distributing the outgoing programmes back to the listening rooms adjacent to the studios or to the various offices in the building, interval signal equipment, Greenwich time signal apparatus, &c. All the switching on and off of the microphones in the studios with their accompanying signal lamps, amplifiers and polarising circuits is done from the control room, and one man seated in a control position is able to control all the studios in the building, the power supply being provided by secondary batteries.

Apparatus has been installed in Broadcasting House which has only come into general use since the building was designed. Control cubicles, for example, enable musicians to control outgoing programmes and hear them on loud speakers without having to sit at a control position in the main control room. The Corporation has also made use of the Blattner Stille system of steel tape recording, which enables any outgoing programme to be recorded or played back on to a transmission or into any studio in which performers are rehearsing. The system is not only used for re-broadcasting a programme, but it is also extensively employed to enable producers to demonstrate mistakes made by artists during rehearsals.

Apart from the quality checking rooms adjacent to the studios, there are others which have received special acoustic treatment, and in which engineers may sit and listen to any outgoing programme. There are also two listening rooms for the use of Press critics or others who may desire to hear a particular transmission under satisfactory conditions of reception. Mention should also be made of two dramatic control rooms in the chain of transmission between the studios and main control room, their function being to enable dramatic producers to use any number of studios up to eleven simultaneously on one transmission and so to mix their outputs in synchronisation and strength as required. In this way, stage management is facilitated in the studios and a completely mixed programme is passed into the control room for distribution to the various transmitters.

Broadcasting House is a wonderful place, which serves to demonstrate the extraordinary progress that has been made in wireless telephony in the course of a few years. Those who listened to the first programmes transmitted once a week from Writtle and subsequently the early transmissions from Marconi House, where, we believe, the musicians were sometimes accommodated in the corridors, little imagined what was in store. The new building is, of course, the outcome of the work of many people. The designers and contractors are far too numerous to mention, but we may say that the architect was Lieut.-Colonel G. Val Myer, who worked in association with Mr. T. Tudsbery. Holland, Hannen and Cubitts, Ltd., were the main contractors for the foundations, and Ford and Walton for the superstructure.

## SIXTY YEARS AGO.

Our attitude sixty years ago towards the vexed question of river pollution was no doubt in keeping with the spirit of those Victorian days, but it was hardly such as we would care to adopt now. In our issue of May 17th, 1872, we reminded our readers of one of Faraday's poetically discursive lectures in which he had surveyed the elements one by one, and had shown that Nature in her bounty had allowed only the harmless elementary bodies and their innocuous compounds to present themselves to the world in their free state. Oxygen, nitrogen, carbon, sulphur, and other elements which would not destroy life were alone found in the free state. Harmful elements, such as chlorine, were safely imprisoned in various compounds. We accepted that view, but having done so we immediately proceeded to develop it in the direction of showing that much of our civilisation and many of our industrial processes were directly dependent upon our ability to set free the harmful elements from their imprisonment, and to apply them under control to certain ends. Chlorine itself provided our chief example. Without possessing means for its liberation, we would, we said, be unable to bleach calico and would not be able to produce paper in the familiar form. Having liberated the harmful elements and set them to do our work, we were faced with the problem of their subsequent disposal and of getting rid of the products which their employment created. In the House of Commons there was at that date a strong movement on foot designed to prevent manufacturers from turning their waste products into the nearest stream. Visions were being conjured up of our streams restored to Arcadian purity and abounding in fish. We sought to shatter that dream with the argument that it could be realised only in a non-manufacturing Arcady. If, we said, some of the proposals then being debated were given the force of law, many manufacturers would be compelled to close their establishments for want of a means for the disposal of their effluents and waste products. In the great majority of cases only two means of effecting that disposal were available—by air and by water. We recalled the days when the muriatic acid formed as a by-product, in the manufacture of soda was discharged into the air to the ruin of vegetable life for miles around, and contrasted the old conditions with those which had followed upon the adoption of the process involving the stacking of wet coke in the factory chimneys and the recovery thereby of the acid in the form of a solution. Some of that solution undoubtedly found its way eventually into nearby streams, but it was far better that fish should die than that the lungs of man should be diseased and vegetation perish. The pollution of rivers might be objectionable, but it was essential, in our view, to the conduct of manufacturing industry. We warned enthusiastic legislators that to impose a ban on that pollution would be severely to hamper, if not completely to stop, many important industrial processes. It may be true that fish to-day do not abound at London Bridge, but the Thames is no longer, as it was sixty years ago, a source of pestilence. The Aire and the Calder may not be exactly pellucid streams to-day, but it would certainly be a difficult task to repeat that letter of protest against their condition which in 1871 was written with no other ink than their water.

The building of a big works for the manufacture of excavators is shortly to be begun in the Urals. The provisional plan provides for an annual output capacity of 2000 excavators, but the works will later be extended and the output capacity brought up to 5000 excavators a year. When completed the works will employ 25,000 workers.

# South African Engineering Notes.

*(By our South African Correspondent.)*

### New Shaft Sinking Record. *April 1st.*

DURING the month of March the South Shaft of the West Rand Consolidated was sunk 400ft., which not only sets up a record achievement for the Witwatersrand, but is also, as far as one can ascertain, a record for the whole world. Congratulations have been extended to Mr. Boyle, the master sinker, and his team from all parts. The shaft is of five compartments, each 10ft. by 5ft., the outside measurement of the timber being 29ft. 6in. by 11ft. 6in. The present depth of the shaft is 1113ft. from the surface—on April 1st, 1932. It is estimated that the shaft will be completed at a depth of approximately 4000ft., but the exact actual and final depth has not yet been decided upon. Active sinking of the shaft, which had been suspended, was restarted on December 31st, 1931, and on that date 7ft. were completed. The footage sunk monthly since the end of 1931 is as follows:—January, 303; February, 317, and March, 400. The cost of sinking for the month of March, including timber and all other costs, was £24 13s. 8d. per foot. This cost includes the entire expenditure incurred at this shaft for all purposes. The shaft is operated on three eight-hour shifts, the total European staff being twenty-eight and the native staff 250. For the month of March ninety-one rounds were blasted. The machines used were C P 5 drills, converted to sinking machines, and an average of ten machines were used per shift.

### Robinson Deep Shaft Down 7730ft.

The operation of the Robinson Deeps enlarged property was successfully carried out during the past year, and the inauguration of a comprehensive development policy has placed the mine in a sound position for maintaining operations on the present basis. In the Turf Shaft section, the lowest workings are now situated at a vertical depth of 7730ft. below surface. The mine milled 1,158,000 tons of ore in 1931 the yield of gold being 5776 dwt. The working profit was £261,771, which is an increase of £29,759, due to an improvement in yield of 0·312 dwt. of gold per ton treated. The development footage for the year was 50,617ft. compared with 37,528ft. in 1930.

### Port Elizabeth Harbour Development.

The big crane on the end of the South Jetty at Port Elizabeth is making steady progress. Up to the present 180 blocks running 10 to 15 tons have been placed in position to form part of the 800ft. solid extension, which is contemplated under the first instalment of the harbour scheme. The crane can now be moved on to this portion of the superstructure of the quay wall, and it is anticipated that from now on the quay will be pushed forward at the rate of 50ft. per month. The new quay wall as authorised at present will extend about 800ft. from the end of the jetty which, when backed with filling across to the rubble mole being run out to the north of the jetty, and equipped with electric wharf cranes, together with road and rail facilities, will form an arm or pier 350ft. in width and having a berth with 35ft. of water at low tide. The new quay is of the gravity section type, constructed of 15-ton blocks on concrete foundations. At intervals of 25ft. the wall will be provided with buttresses, which will carry the reinforced concrete beams on which the inner rail for wharf cranes will be situated. The buttresses will also provide stability against the pressure of the filling behind the wall. The blocks are set by divers with the aid of the Titan crane, and to facilitate the work of the divers the Titan crane is provided with special hydraulic gear, by means of which the block can be controlled to a nicety. Very shortly an old disused dredger will be moored ahead of the wall. This craft has been equipped with a crane and will carry concrete-mixing plant, and when brought into commission will enable the concrete foundations for the wall to be put down ahead, independent of the Titan crane. The height of quay surface above low water is to be 17ft. This part of the scheme is to be pushed ahead rapidly, so that within two years' time ship passengers will step on to a modern quay with road and rail facilities. The liners mooring along the quay will be protected to a very considerable extent by the rubble mole to the north of the jetty, which will be continued for 1000ft. beyond the 800ft. extension of quay wall. There appears to be an intention to reduce the extension by 100ft., so that it will be only 700ft., but this does not seem to be quite settled yet. The total length of the rubble mole from its root will be 3100ft.

### State Iron and Steel Works. *April 8th.*

It is interesting to note that matters have reached such a stage in the development of the S.A. Iron and Steel Corporation's works that the time has come to decide upon the question of the steel sections likely to meet with the greatest demand. To this end, the Corporation called a meeting of the most interested parties last March in the Corporation's offices, 83, Marshall-street. The meeting was very well attended, and it is expected as a result of the discussions that the State Steel Works will be able to minimise the number of sections to be turned out, and be able to cater for all needs with a minimum number of rolls.

### Natal Coast Electricity Supplies.

The extension of electric supplies from Umbogintwini to Karridene marks the most important era in the development of the Natal south coast that has taken place for years. Durban Town Council evidently expects that practically every house and business concern will take supplies. It is hoped that supply in one area will be given by the end of May and throughout by the middle of the year. It is proposed to cover the whole of the south coast suburbs from, but not including, Umbogintwini village, right along Kingsway to Amanzimtoti River, and other villages, Warner Beach, Doonside, Winkle Spruit, Illovo River, Illovo Beach, and Karridene. The distribution will be practically continuous right through, and as far as possible all thoroughfares along which buildings are already existing will be served.

### Use of Electricity Increasing.

From the statistics of industries in the Union published by the Office of Census and Statistics, it is found that the number of power generating plants in the Union was 232 in 1929–30, as against 148 in 1926–27. The value of land and buildings for the same period was £4,205,453 and £2,425,171 respectively. In 1925–26, the plant, machinery and tools were valued at £14,732,900, and this figure rose to £19,046,421 in 1929–30. Employment figures rose from 7610 to 8984, salaries paid increased from £1,026,532 to £1,322,283, value added to materials was £6,525,421. The total number of units generated was 1,761,206,000 in 1925–26 and by 1929–30 the number of units generated was 2,453,656,000. This progress has been by no means spasmodic, and affords tangible proof of the manner in which the electrical industry is being developed.

### Lower Zambesi Bridge. *April 15th.*

Work is at present proceeding apace in connection with the construction of the Lower Zambesi Bridge, now being carried out by the Cleveland Bridge and Engineering Company, Ltd., Darlington. Although there are few outward and visible signs of the bridge itself, the enormous amount of preparatory work is well advanced and is indicated by a complete unit of a powerful well sinking set moored in the river and the erection of cranes and other machinery at the sites of some of the piers on the low bank on the Sena side. The building of many barges for the transport of material is proceeding, and one of the light draught steamers sent out from England in sections has been launched and equipped with a powerful boiler. Quarries are being operated; at D'Anna and Sena workshops equipped with modern power tools are in full working order, as also pumping machinery for the water supply and the whole of the construction camp is electrically illuminated. Notwithstanding concentration on the preparatory work and the mass of detail involved in organising and executing the many items of plant and machinery, the permanent work has been started. The foundations for the bridge piers at the D'Anna end of the bridge have been excavated and are being concreted, and the D'Anna abutment of the bridge is well above ground level. Some 4000 natives are employed on the construction of the 25 miles of railway between Murroca and Sena. About two million cubic yards of earthworks are involved in the construction of this part of the new line, and it is hoped to complete the embankment in April.

### State Steel Works.

In placing the various contracts for the Union's State Steel Works provision has been made for as much work as possible to be done in South Africa. Thus the steel frames of the buildings, weighing about 10,000 tons, are being fabricated by the Union Construction Company, whose works are at Germiston, and the establishment of which is the first important result in subsidiary industrial development following in the wake of the Pretoria enterprise. Being established under the best auspices, the Union Construction Company is certain to become a large and important consumer of Pretoria steel, presuming that all the expectations with regard to that ambitious concern are realised. A considerable proportion of the capital cost of establishing the Pretoria works will be spent in South Africa and will, no doubt, bring business and employment to many existing South African industries, though probably at huge cost to the ratepayers of the Union. The erection of the plant at Pretoria and generally the establishment of the works is under the direction of the Chairman of the Committee of Consulting Engineers, Mr. A. K. Reese. Certain sections of the plant are being designed in this country, such as mining plant, conveying plant for ore, dolomite, &c., the power station cooling towers, &c. Since the whole of the works will be electrified, the electric equipment will be a very important section, and Messrs. Merz and McLellan are advising on the lay-out of the equipment in connection with that part of the steel plant. The civil engineering work is under the direction of Mr. F. E. Kanthoek, who is consulting civil engineer to the Steel Corporation. In this way it is believed by the Corporation that it will obtain a combination of the best type of iron and steel manufacturing plant and the benefit of the local knowledge of South African engineers and other experts which, the Corporation considers, is necessary for the smooth carrying on of the work of establishing the industry.

### Call for Electric Appliances.

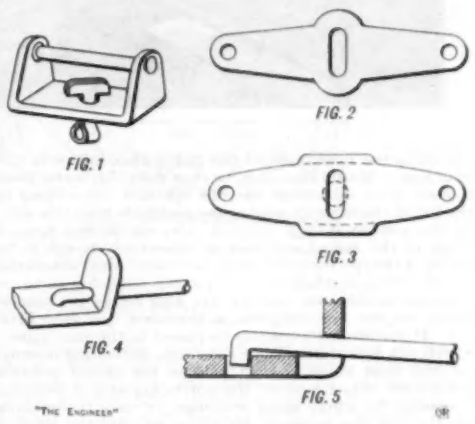
At the end of 1924 domestic electric appliances had gained a very secure footing in Durban city. By that time 803 stoves and 947 water heaters had then been installed, but since that date, when the municipality decided to adopt vigorous propaganda, progress has been little short of phenomenal. The following figures illustrate the growth in the installation of domestic electrical appliances during the period under review. In 1925 437 stoves were added and there were 1240 in all at the end of that year. In 1931, 1460 stoves were added and the total connected was 9149, while from January 1st to February 20th, 1932, 173 stoves have been added and there are now 9322 connected. Taking water heaters, we find that in 1925 386 were added and there were 1333 connected altogether, while at the end of 1931 there were 610 added and the total connected was 5676. In 1927 63 refrigerators were connected, and at the end of 1931 804 had been added during the year and the total connected up was 1738. From January to February, 1932, 143 were added and the total is now 1881. Eighty-seven water heaters were added from January to February and there are 5763. For the year 1925 the revenue from electricity was £285,733 and there were 14,982 consumers for lighting, heating, and power. For 1931 the total revenue was £492,578 and the total number of consumers 22,667.

# The Contraction of Holes by Press-work.

By HENRY C. LANE.

FIG. 1 is a perspective sketch of a pressed swivel shackle which I designed to possess strength equivalent to an all-forged "barrel" swivel, without its heavy cost, and to allow the attachment of the bolt to a chain link without the necessity of welding the link through the bolt. The assembly of the bolt to the chain was described in THE ENGINEER for October 16th, 1931. The complete design is the subject of a recent patent, and has the virtue of being extremely simple. The production methods are by no means intricate, but can be described as novel. The principles involved might well be of use in many other production propositions.

A hole is removed from the centre of the shackle to allow the head of the bolt to be zigzagged through it. My first attempt at a blank shape for the shackle is indicated in Fig. 2, but this form resulted in a square hole after contraction. The shape of the blank finally adopted is shown in Fig. 3. This form results in a swivel hole, which is to all intents and purposes round, and of a diameter well under the size of the bolt head. The shackle is bent as in Fig. 1, the bolt head is passed through the hole, and the edges of the shackle are squeezed in a press as indicated by the dotted lines in Fig. 3. With satisfactory tools the production is extremely simple, but it may be worth while to mention one or two important points. The minimum amount of clearance is given to the blank




punch in relation to its die in order that the edges of the blank shall present as square a face as possible to the squeezing punch. The squeezing operation is carried out in a hand press, which should have the least possible amount of play in the slide. Gauging for the squeezing operation has to be carried out from the actual edges that are to be squeezed. Grooves are cut in both the punch and die to accommodate the bent shackle which completely alters its dimensions during the operation. There is doubtless a limit to the thickness of stock that can be handled on this principle. In the present case, the overall width of the shackle blank is $\frac{7}{8}$in., and the thickness 0·104in.

The sketch, Fig. 4, indicates the features of an earlier patent of mine, whereby a hard steel wire spring is firmly assembled to a mild steel pressing. No really firm joint could be obtained by endeavouring to rivet the end of the steel wire. Tightening is carried out in effect by riveting the mild steel around the wire. The end of the wire is bent to an L shape, and passed through a hole at the bend of the pressing. The toe of the L shape end is threaded through a hole in the main body of the pressing. A groove die exactly fits this wire end when the assembly is inverted, and a circular chisel punch contracts the hole around the wire end. Support is given to the mild steel during the process by the grooved die as far as possible, the wire itself acting as a satisfactory support across the groove. The joint is quite firm in itself, but additional strength and rigidity are obtained by arranging the pressing as shown in the sectional view in Fig. 5. The holes in the pressing are situated so that, while they allow the easy threading of the wire spring up to the point shown, complete threading is impossible by hand. In the riveting tools, the circular punch completes the threading in the riveting operation and locks the wire securely in position. Gauging for riveting is carried out by locating the spring end in the groove of the die. The tools have to be set with extreme care to ensure the best results. The operation in question is carried out in a power press on wire, 0·202in. diameter, and in mild steel, 0·144in. thick.

# THE PLASTIC DEFORMATION OF METALS.

PROFESSOR DR. F. KORBER, Director, Kaiser Wilhelm-Institut für Eisenforschung, Düsseldorf, delivered the twenty-second annual May lecture of the Institute of Metals in London on Wednesday last, his subject being "The Plastic Deformation of Metals."

Basing his remarks on the results of a series of investigations which had been conducted at Düsseldorf during recent years, the lecturer dealt with the stress relationships and with the flow of the material during the most important of the mechanical shaping processes. The conditions requisite for starting plastic flow and the possibility of drawing conclusions from the resulting flow phenomena as to the distribution of stress in the material at the inception of deformation were discussed, and the disturbances in the material in consequence of the more marked deformations in drawing, extrusion, and rolling were traced by a suitable method of investigation. The results were compared with the deformation structures as illustrated by X-ray methods. The knowledge of the

deformation processes so obtained enabled conclusions to be drawn as to the energy or power used in the shaping operations. An exact analysis of the course of deformation in the transition zone enabled reliable estimates of the internal losses during the alterations in form to be made. Quantitative treatment of the stress relationships which occurred in the zone of deformation was, said the lecturer, possible in so far as the pressure created at the surfaces of contact between the tool and the material was known by actual measurements. From the results of determinations along the roll gap of the pressure between the rolls and the stock being rolled, a complete quantitative presentation of the distribution of stress in the transition zone between the rolls had been formulated.

## Provincial Letters.

### THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

**Dilatory Trade.**

BUSINESS in iron and steel and engineering circles in the Midlands and Staffordshire still moves slowly, and its loitering character has not been changed this week by the approach of the Whitsun holiday break. Indeed, rather the reverse has been the case, consumers of iron and steel having shown decided inclination to put off business until the resumption of operations at the works. As there is a very poor reserve of orders in most of the industries in the area, the holiday is likely to be prolonged beyond its customary length of two or three days. In many cases plant will be idle for a full week at least. Conversations on 'Change in Birmingham this week, and the general attitude towards business, show that, apart from seasonal variations, there is not much change in the trade position from that which existed immediately prior to the imposition of tariffs. There are no new features in the iron and steel market, and though the tone remains reasonably strong there is little tangible evidence of improving prospects in the near future. Most of the works in this area are operating irregularly. Current consumption of iron and steel is at a low rate, and as heavy stocks of foreign material are still available, there is little prospect of increased demands being made upon local producers for some time to come. The heavy trades in Staffordshire continue very quiet. There is some movement towards the putting into hand of development and replacement projects which have been held up on economic grounds or pending the improvement of the general position. In some branches of engineering inquiries are reported to be in circulation with regard to some of these schemes, though it must be admitted little of a concrete nature has yet accrued, at any rate, as far as I can ascertain. However, some encouragement is derived from the improved expectations. Staffordshire re-rollers continue to be short of orders, and, generally, buying is on a restricted scale. Stamping and casting shops continue to show a reasonable activity, and there has been a welcome improvement in this area in the motor and allied trades. A number of the foundries are slightly better employed, but activity is best in the light castings branch, the output of the heavy engineering foundries remaining much below capacity. The electrical trades continue brisk. Firms making dynamos and pumps are fairly well situated, the export side being a pleasing factor; but the demand for plant for mining and industrial equipment in the home market has not reached expectations. General electrical plant is keeping local firms well employed, and the call for small electrical products remains satisfactory. Consideration continues to be given to the manufacture of products formerly made abroad, and now subject to duty. There has been some developments in this connection, but in very many instances investigations have not yet been completed. There is, however, a reasonable prospect of benefit from the change, and it should eventually extend to the iron and steel trades as in many instances British material is likely to form the basis of these products. The improved demand for heavy edge tools is maintained, and overseas business has now assumed moderate proportions. There is no more movement in the nut and bolt industry in the Darlaston area, while tube makers and boilermakers are working at about recent rates. The hardware trade is quiet. Some firms making hollowware are more briskly employed than of late. This applies particularly in the case of aluminium wares. In the Midlands area, as in other industrial centres, unemployment increased considerably last month, and the official returns are not of a very cheering nature. Manufacturers and industrialists refuse to become despondent. Every effort is being made to get the best from the small amount of business at present available, while hope is still entertained of trade progress in the near future.

**Finished Iron Prices.**

Trade is so bad and competition so keen in the Staffordshire finished iron trade that prices are at last giving way. Marked bars are the one invulnerable point. Makers adhere firmly to the £12 level, and they continue to receive small orders sufficient to keep their plant in operation, though far from fully. Moreover, their order books are of no magnitude, orders coming in from day to day and being completed without delay. Pressure in the Crown bar branch, however, has caused leading makers of Staffordshire bars to reduce their selling figure by 5s. to 10s. per ton. Firms which, until recently, would not accept business at below £10 per ton are now willing to accept £9 15s., and in some cases £9 10s. At the other end of the scale makers from this and other areas who have been quoting £9 5s. for their product are now open to negotiate at £9 upwards. There are precious few orders to be had, however, even at these prices. Common bars for the nut and bolt trade have declined in value by half a crown per ton, being now offered at £8 5s. delivered. Against this price is one of £6 to £6 5s. quoted by Belgian rivals for No. 3 iron, which manufacturers contend answers their purpose quite well. There are large stocks of this material at local works, and buying of either native or foreign material is likely to be extremely quiet for some time to come. Wrought iron tube strip continues to be quoted at £10 10s. per ton, with some makers asking slightly more. There is a moderate demand.

**Pig Iron.**

No development of demand has taken place in the pig iron branch of the market. Specifications from the foundries are still very light, an indication of the poor activities in the district. Consumers show no inclination to renew contracts and blast-furnacemen are faced with the prospect of either reducing output or adding to existing heavy stocks. It was anticipated that larger tonnages wuold have been taken up by consumers in this area before now, but such has not proved to be the case, and even the improved inquiries lately reported have not developed into concrete business. Northamptonshire blast-furnacemen are worse off than those in Derbyshire, despite the fact that they continue to dispose of a moderate amount of iron in Northern and Scottish markets, where they are free to compete against makers from other areas and from the Continent without price restriction. Many Derbyshire furnaces have associated pipe foundries which take a large proportion of their output, and in this case the quantity going into stock is not so great. The gradual accumulation, however, is responsible for unusually heavy storages at the blast-furnaces. Values are upheld in all cases at the Association level. They are on the basis of £3 6s. for Derbyshire No. 3 foundry, and £3 2s. 6d. for Northamptonshire.

**Steel.**

Conditions in the steel market are unchanged. Demand, especially for finished steel, is very dull, and there is insufficient business passing to afford a test of values. Quotations are generally unchanged. Angles are £8 7s. 6d., tees £9 7s. 6d., joists £8 5s., ship, bridge and tank plates £8 17s. 6d., each subject to their respective rebates to users of British steel only. Boiler plates made £8 7s. 6d. to £8 10s., small bars re-rolled from foreign billets £6 7s. 6d., all-British bars £7 5s., mild steel billets £5 5s. to £5 7s. 6d., sheet bars £5 to £5 5s., and Staffordshire hoops £9 10s. Steel is on offer from the Continent at lower rates than a week ago. Billets are to be had at £4 12s. 6d., and sheet bars at £4 15s., though some quotations are half a crown above these figures. Joists and sections show scarcely any difference on the week, £5 7s. 6d. being quoted. Small bars are £5 5s. to £5 7s. 6d. The scrap market is dormant. Steel scrap has been offered at exceptionally low prices, but the steelworks are reluctant to take delivery of further consignments or to place new orders.

**Galvanised Sheets.**

Though makers of galvanised sheets are doing their best to uphold prices, they are unable in many instances to get the full figure of £9 10s. per ton for 24-gauge galvanised corrugated sheets. Export orders of any bulk could, undoubtedly, be placed at £9 7s. 6d., but for small tonnages £9 10s. would probably have to be paid. The higher price also applies to home business. It is not so much internal competition that is at the root of the trouble, though mills are poorly employed and orders are very scarce, but competition from Belgian makers, who are fighting hard for overseas trade. A few local mills adhere firmly to the generally recognised quotation, contending that anything below this figure is unremunerative. There is a better call for black sheets, the motor industry having increased its specifications.

**Tin-plates.**

There is hardly any demand in this district at the moment for tin-plates, which are on offer at 15s., and in some quarters even less. Business appears to be as dispirited as it is reported to be in other areas.

**Joint Sewage Works.**

Walsall Town Council has approved an agreement with Walsall Rural District Council for the provision of joint sewage works at Goscote at an estimated cost of about £39,000. Walsall already had sewage disposal works at Goscote, but, in view of housing developments in the adjacent districts, the works will not be adequate for future requirements. In these circumstances a joint scheme is considered advisable in the interests of economy. A start with the work, it is understood, is not likely to be made until next January, but it is expected the works will be in operation by October, 1933.

**Warwickshire Miners' Wages.**

Miners in the Warwickshire coalfield are to receive slightly better remuneration during the current month. The new rate of wages, as fixed by the Warwickshire Miners' Joint Wages Board, will be calculated on 48 per cent. of the 1911 wages basis—an increase of 1 per cent. on the wages paid during April.

### LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

**Textile Machinery by Train Ferry.**

TRANSPORT of textile machinery to the Continent direct from Lancashire *viâ* the Harwich–Zeebrugge train-ferry service is no new thing, but it is claimed that the recent carriage by this route of a consignment of spinning machinery from Bolton to Italy is unique. Hitherto, the view has been that spinning plant was of too delicate a nature to be transported without very careful packing. In the case in question, however, the machinery, weighing about 10 tons, was loaded at Bolton in a covered wagon without any packing. On arriving at Harwich, the wagon was run on to the train ferry and at Zeebrugge transferred to the Belgian lines and carried across the Continent to its Italian destination. No more than about 2 cwt. of the most delicate parts of the installation was packed. It may be recalled that a more notable example of the utilisation of the Harwich–Zeebrugge train-ferry service by Lancashire engineers occurred in the closing months of last year, when the London and North-Eastern Railway elaborated plans for the direct transport from the works of the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, of electric locomotives and other railway electrification material for the Hungarian State Railways, for use on the 80-mile stretch of the electrified line from Budapest to Komáron. The total weight of the material involved was said to be in the neighbourhood of 1400 tons, and the distance from Manchester to Budapest something like 1200 miles.

**Manchester Locomotives for Ireland.**

Arrangements have been made for the transport by the London, Midland and Scottish Railway Company of five locomotives which Beyer, Peacock and Co., Ltd., are completing at their Gorton Works, Manchester, for the Great Northern Railway of Ireland. All five are to be delivered at Dundalk before the end of June, one locomotive being shipped each week-end by the London, Midland and Scottish Company's steamers from Holyhead to Dublin.

**Contract for Structural Engineers.**

The contract for the supply and erection of the steel framework and pile foundations for the new Spa Royal Hall, Bridlington, to replace the building recently destroyed by fire, has been placed with Heenan and Froude, Ltd., structural engineers, of Newton Heath, Manchester. This is one of the few important contracts for some months that have come the way of Manchester firms in this branch of engineering.

**A Reduced Dividend.**

Smaller profits are foreshadowed by the announcement of the directors of the Chloride Electrical Storage Company, Ltd., of Clifton Junction, Manchester, of a final dividend of 5 per cent., making 10 per cent., free of tax, for the twelve months to the end of March last. This figure compares with 15 per cent., free of tax, for the previous financial year.

**Non-ferrous Metals: Fresh Weakness.**

Undoubtedly, major interest in the non-ferrous metals market during the past week has centred on the tin section. Plans for the further curtailment of the output of the metal promise to be much more drastic than was at first envisaged, and coupled with the reduced production is the declared aim of the International Tin Committee to bring the price of the metal up to £200 per ton. It remains to be seen, however, what degree of success the latter part of the plan achieves, for something of a similar nature has been attempted before within the last year or two, and has failed. Nevertheless, interest in tin during the past week was much stimulated by the announcement, and heavy buying on speculative account brought prices up to more than £10 a ton above the levels current a week ago. Serious reaction, however, occurred in the early days of the present week, and at the moment of writing values are approximately 10s. lower on balance for the week. The call for copper from the consuming industries remains very moderate, and prices of standard brands have lost ground to the extent of about £1 a ton, after an upward movement in sympathy with tin. Lead also has met with a poor demand, and a fall of £1 a ton has brought quotations down to very low levels, the whole of the recovery in recent weeks having been wiped out. Some improvement has latterly been observed in the statistical position of spelter, and with rather a better inquiry for the metal, the decline on balance in this section has amounted to no more than 5s. a ton.

**Iron and Steel.**

The outlook for the iron and steel trades locally is no brighter than before, and poor reports as to current conditions, more especially in the steel section, have been circulating here this week. There is rather a slow movement of foundry iron in connection with new forward contracts, with deliveries into consumption in the Lancashire district much about the same as before. Prices are steady at 67s. per ton for Derbyshire, Staffordshire, and Cleveland No. 3, all delivered equal to Manchester; 65s. 6d. for Northamptonshire; 62s. for Derbyshire forge; about 86s. 6d. for Scottish pig; and 81s. for West Coast hematite. Sales of bar iron are slow still, with Lancashire Crown quality material still quoted at £9 15s. per ton, and best bars at £10 5s. Specifications in almost all sections of the steel market, including special descriptions, are on a very disappointing scale, and new orders are limited to small quantities for early delivery, and amount to very little in the aggregate. So far as prices are concerned, however, the position is much the same as before, with small re-rolled bars at about £7 per ton, boiler plates at £8 12s. 6d., tank plates at £8 17s. 6d., joists at £8 15s., and sections at £8 7s. 6d.

BARROW-IN-FURNESS.

**Hematite.**

As far as can be ascertained, the position in the hematite pig iron market remains about the same. Inquiries elicit the fact that it is too early to discover what effect the tariffs will have upon the trade locally, owing to the fact that buyers of foreign iron and steel hold stocks, and not until those stocks are used up will it be possible to gauge the trend of business. In the meantime, Barrow is putting two furnaces in blast again, as a result of the rail mills restarting, and also because stocks have come down. It is impossible to say at the moment how long production will continue. Continental and American business continues to be dull. The iron ore trade is very quiet, but the two furnaces being put into blast will improve the demand somewhat. The steel market is quiet, and although the rail mills are getting to work again, further orders will be required if they are to be kept going. The hoop mills are better situated, and business continues to be moderately good.

## SHEFFIELD.

*(From our own Correspondent.)*

### The Heavy Steel Trade.

THERE is no sign of improvement in the ordinary branches of the steel trade; on the contrary, a number of firms in the East-end of Sheffield report a shrinking tendency in orders and inquiries, and an increasing growth in the proportion of small orders. It is thought that uncertainties as to tariffs are holding up business in many directions, and that present difficulties may be regarded as temporary. The proximity of the Whitsuntide stoppage may also be partly responsible for the present state of things, and there is a probability that that holiday will be protracted. Production of open-hearth steel shows little change. At Templeborough, Parkgate, and Stocksbridge, the tonnage turned out is large, though far below the capacity of the plants. At other works, operations have been reduced. There is no further expansion to report in the Lincolnshire production. There is much slackness at the rolling mills and forges, while work for the railways and shipyards remains at a very low level.

### A New Open-hearth Plant.

The open-hearth furnaces at the Vickers Works of the English Steel Corporation have been dismantled, prior to the erection of a new and up-to-date plant, and in the meantime melting operations are being carried on at the Grimesthorpe works. Three furnaces of the latest type are to be built at Vickers Works, which will have a productive capacity more than equal to that of the five furnaces which are being displaced.

### The Lighter Side.

The lighter sections of the steel trade continue to give a better account of themselves than the heavy branches. It is questionable, however, whether even here activity is as marked as it was a month ago. The automobile industry keeps up its demands on Sheffield fairly well, and is responsible for a large volume of work, and similar conditions exist in the stainless, acid-resisting, and heat-resisting steel branches. There is considerable briskness in steel strip, whether cold or hot wrought, and also in wire and permanent magnets. The growth of wireless telephony has brought a valuable quantity of work to the last-named section. Demand for crucible steel is disappointing, and only a few firms are able to report moderate order books. One of the brightest sections is that concerned with the production of tools. So large is the demand for twist drills and similar appliances that several makers are finding it difficult to cope with orders, although they have placed their factories on full time. There is also great activity in cheap tools. In some branches slackness is still to be found. One of these is circular saws, the export market for which has been depressed for several months.

### A Smokeless Furnace.

An invention just perfected by Mr. George Clark, of the firm of George Clark (Sheffield), Ltd., North British Steel Works, Sheffield, promises to make a valuable contribution to the prevention of works smoke. After experimenting for some fifteen years, during which time he has spent between £3000 and £4000 in the work, Mr. Clark claims to have evolved a method of burning coal in a mill furnace which has all the advantages of the old method without any of its disadvantages. The coal-fired reheating furnaces generally used in mills and forges are admittedly crude, and extravagant in fuel consumption, while the emission of black smoke from the chimney stacks is difficult to control. By Mr. Clark's method, it is stated, a saving of fuel of up to 30 per cent. is achieved, no smoke is thrown into the atmosphere, and the quality of the work produced is superior to that from any other kind of furnace of which Mr. Clark has knowledge. The saving of coal is obtained by burning the smoke and gases, which, under the old conditions, pass out unburned into the atmosphere. Control is exercised at four points, namely, the damper at the top of the chimney; the air ducts under the fire-grate; forced draught downwards through the roof of the furnace; and forced draught upward through the grate bars. Messrs. Clark have equipped one of their reheating furnaces with the new apparatus, and they are so satisfied with the result that they are to extend the application to all their furnaces. Great interest is being taken in the new type of furnace by members of the Sheffield District Rollers' and Tilters' Association, whose representatives have made investigations at the works.

### The Beckton Coke Oven Plant.

The Koppers Coke Oven Company, Ltd., of Sheffield, was the designer and builder of the battery of sixty coke ovens at the new Beckton gasworks, the largest in the world, which were opened by the Prince of Wales last week. The plant will deal with 1200 tons of coal per day, producing about 850 tons of coke and over 15 million cubic feet of gas, in addition to the by-products of tar, ammonia, and benzol. It has been proved that ovens must be uniformly heated to produce coke of the best quality, and this is claimed for the Kopper oven, which gives a full output at a lower temperature than is usual with other coking plants, the amount of fuel used being less in consequence. The plant is heated by producer gas, and in that respect it is the only one of its kind, the gas being generated in a Koppers producer working on small coke.

### Humber Bridge Finance.

The financial proposals in connection with the proposed bridge over the Humber have been announced. The Humber Bridge Committee of the Corporation has been in negotiation with Hambros Bank to provide the necessary funds, and the proposal is that the whole cost shall be met by the issue of £2,000,000 5 per cent. debentures, redeemable in forty years at par. The Bridge Board would borrow the money upon the security of the tolls. It is provided that the Hull Corporation and other contributing local authorities, instead of making any capital contribution, should guarantee for a period of ten years any deficiency in tolls to meet interest, sinking fund, and maintenance charges.

### Gainsborough Gas Progress.

The Urban District Council of Gainsborough has decided to apply to the Ministry of Health for permission to borrow £15,200 for the installation of a retort house plant at the Gainsborough gasworks. Woodall, Duckham, Ltd., the contractors, undertake that £6000 of the contract shall be paid out in local labour.

### Trade with the United States.

There was a considerable falling off in Sheffield's trade with the United States during the first quarter of this year, as compared with the corresponding period of 1931. The value of the steel exported was only 31,775 dollars, as against 82,100 dollars, and, even when allowance is made for the increased value of the dollar in relation to sterling, the reduction is about 50 per cent. The value of the cutlery exports was 8360 dollars, as compared with 10,246 dollars.

### Cutlery and Plate.

The ordinary trade in table knives, silver, and electro-plate is still suffering under depression, and orders from retailers are mostly of small proportions. There is, however, a good deal of activity in scissors, razor blades, cheap pocket knives, bazaar, and gift goods, and unplated spoons and forks. A deputation from the cutlery trade has interviewed the Tariff Advisory Committee in an endeavour to get the rate of duty increased from the present 20 per cent. to 50 per cent., and it anticipates that its request will be met in part, if not wholly. The reduced duty has had an effect on the demand for safety razor blades, but this relates chiefly to those of higher prices. Cheap blades are still selling freely, and the works are well employed. The export trade continues brisk.

### Bridlington Waterworks.

The first sod has been cut of a new reservoir which the Corporation of Bridlington is constructing on the top of White Hill, the highest point in the district. The reservoir, which is to cost £20,000, will hold half a million gallons, and will be completed in about six months. It will enable the Corporation to supply a number of villages north and south of Bridlington, if required.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### New Teesside Industry.

IMMENSE industrial possibilities are foreshadowed at Billingham-on-Tees, near Middlesbrough, following the discovery of white cement rock underneath the works of the Imperial Chemical Industries, Ltd. This cement rock, the technical name for which is anhydrous calcium sulphate, was used as raw material for fertilisers. Then Major V. Lefebure, of Darlington, began experimenting, and what has hitherto been a waste product has been converted into a material of manifold uses. The work was done at the research laboratories of Imperial Chemical Industries, Ltd., and the result is now a product for making all kinds of building materials, such as cements, plasters, building blocks, and decorative finishes. A geological survey at Billingham reveals that there are 9 square miles of white cement rock below the surface. Some of it is 250ft. in thickness, and it is estimated that there must be between 2 and 3 thousand million tons, which will last for hundreds of years. In some places the seam is quite close to the surface, and in other places it is at a considerable depth, necessitating the sinking of shafts. Large works are now in course of erection at Billingham to exploit the discovery, and world patents have been taken out so that the industrial advantages will accrue to this country. In its manufactured state white cement rock can be sawn like a piece of wood, and nails and rivets can be hammered into it with complete safety.

### Cleveland Iron Trade

Some slight improvement in the demand for Cleveland pig iron encourages hope that the limited make will shortly be fully absorbed. At present output is little in excess of current needs, and stocks are light. Most of the pig iron is going into home use, largely at producers' own works, but market transactions are not entirely confined to negotiations on home account. Overseas trade is still very quiet, but foreign customers are taking more interest in this market, and Continental firms have placed one or two small orders for both Cleveland and East Coast hematite pig iron. Ironmasters are still unable to sell Cleveland pig iron to firms in Scotland, except on specially low terms, owing to the continued keen competition for Scottish trade, but to buyers elsewhere they hold firmly to 61s. for No. 1 quality, 58s. 6d. for No. 3 G.M.B., 57s. 6d. for No. 4 foundry, and 57s. for No. 4 forge.

### Hematite Pig Iron.

Producers of East Coast hematite pig iron hope for early change for the better in the unsatisfactory statistical state of the industry. They look for some enlargement of local consumption and further sales to customers in the Sheffield district and in the Midlands. Mixed numbers are steady at 63s. 6d., and No. 1 quality is at a premium of 6d.

### Ironmaking Materials.

There is next to nothing doing in the foreign ore trade. Round about 15s. 6d. c.i.f. Tees is given as the price of best Rubio. The coke market shows no sign of improvement, and good blast-furnace qualities are on offer at 15s. 9d. delivered at the works.

### Manufactured Iron and Steel.

The manufactured iron and steel trade is without new feature of moment. The market has made a disappointingly slow response to the imposition of import duties. Ultimate results will, of course, be favourable, but international trading conditions are in a chaotic state, and home demand is limited by the existence of heavy stocks of material assembled in anticipation of new tariffs. Works keep fairly busy on the production of constructional steel, but there has been a lull in fresh inquiry in this section during the past two or three weeks. In other sections orders are nearly all for small tonnages and it is difficult to preserve continuity of operations. Prices are unchanged.

### The Coal Trade.

The general position of the Northern coal trade is still very disappointing. There are no signs that the demand is any better, and idle days are common at the pits in both Northumberland and Durham. Both producers and merchants state that inquiries are at a very low ebb, and that there is no immediate prospect of improvement. The home trade is tending rapidly to seasonal quietness and the barriers abroad have made a great difference to local business. In the Tyne alone there are 154 vessels laid up, and among them are colliers which are idle on account of the lessened trade to Hamburg and other German ports, France and Belgium. The small amount of extra business secured in other directions is an insignificant set-off against the lost Continental orders owing to import quota and licence restrictions. The collieries in the two counties were never confronted with so many difficulties as they are just now. Efforts to secure more coal orders from Canada for this district are being steadily continued by local firms, but evidently are not yielding a great deal so far. The latest news is that a Newcastle firm has booked a small order for 1500 tons of Northumberland coal. Buyers in the Dominion are evidently experimenting with the coal from this district. If the results and price are satisfactory, buying may expand. Northumberland steam coals of every description are abundant, and there is little movement in any brand. Best qualities are weakly held at 13s. 6d. and smalls, which are in large accumulations on the ground, at 8s. 6d. Tyne prime steams are also in excess of requirements, and nominal at 12s. 9d. to 13s. These prices can be shaded through second-hand holders. A steady volume of bunker coal trade has been passing at North-East ports for many weeks, but during the past few days there has been a steady decline. The output of this class of coal being difficult to clear for other uses, stocks are decidedly plentiful. Sellers are pressing supplies on the market at the fixed minimum, the nominal quotation for best being 13s. 6d. to 13s. 9d., but the position favours buyers. Good ordinary bunker qualities are a drug on the market at 13s. In Durham County all classes of fuel are more or less neglected, and prices are at minimum level. The slackness does not belong to any particular description of fuel, but is being experienced by every sort at the moment. Gas coal of all grades is plentiful and weakly held at 14s. 6d. for best qualities, and 13s. to 13s. 6d. for secondary kinds. Coking unscreened and coking small all offer at the fixed prices, ranging, according to grade, from 12s. to 13s. 9d. Cokes are also suffering from a scarcity of buyers. Gas coke is in slow demand for export, and stocks are slowly increasing, prices remaining unchanged. Patent oven coke outlook is not bright, and values are easy at 14s. 6d., with superior qualities at 16s. to 18s.

## SCOTLAND.

*(From our own Correspondent.)*

### Steel.

GENERAL conditions in the Scottish steel trade still fail to show an improving tendency. Orders for heavy steel for either home or export account are exceedingly scarce. Specifications for shipbuilding materials are very much required, but prospects of improvement in this respect are not favourable, in view of the dearth of new shipbuilding contracts. The new tariffs imposed about two weeks ago have had little effect on business in Scottish steel products so far. It is anticipated that at the end of the three months experimental period the Advisory Committee will make changes in the tariffs on raw materials bearing a duty equal to or higher than that imposed on finished materials with which the consumers compete. In the case of rivets, for instance, makers have to face a duty of 33⅓ per cent. on imported rivet bars, while rivets for shipbuilding purposes are imported free.

### Steel Sheets.

In the black sheet trade the lighter gauges are better off for specifications than the heavy descriptions. Galvanised sheets enjoy a moderate turnover. Inquiries from Canada are improving, and makers look for further expansion with the Dominion, and are also hopeful that China will soon be in the market for large tonnages for reconstruction work in the Shanghai area.

### Tubes.

Business in the tube trade is exceptionally quiet, and many of the works are closed down.

### Iron.

In bar iron intermittent working is the rule, and the same may be said of the steel bar re-rolling industry. So far as iron is concerned, the margin of difference between home and imported material is still considerable, despite the tariff duties. Owing to the duty on Continental billets, makers of re-rolled steel bars have advanced their prices to £6 10s. home and £6 7s. 6d. per ton export, and find orders far from plentiful.

### Scrap.

The demand for scrap is very restricted, and only small lots are changing hands with prices about 37s. 6d.

for heavy steel and from 47s. 6d. to 50s. per ton for cast iron machinery.

**Pig Iron.**

The number of furnaces in operation remains at six, and the output is still more than ample to meet all demands. Imports from abroad have not been quite so prominent of late, the only cargo mentioned during the past two or three weeks being one of 250 tons from Calcutta. Exports continue small, last week's total only amounting to 70 tons, 40 tons of which went abroad, compared with 499 tons (395 tons foreign) in the same week last year.

**Coal.**

In the West of Scotland and Lothians districts, most, if not all, qualities of fuel are in ample supply for early delivery, home and export demands being on very restricted lines. In the Fifeshire area, however, owing to the effects of the strike, and larger arrivals of tonnage to load coal, some qualities are scarce and prices have appreciated. This is particularly the case in respect to navigation and steam qualities and treble nuts. In other areas smalls are very plentiful at about minimum prices. Aggregate shipments amounted to 240,230 tons, against 238,880 tons in the preceding week, and 209,099 tons in the same week of last year.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**The Coal Trade.**

ACTIVITY has been maintained in the anthracite section of the industry, but all that can be said of the steam coal department is that the conditions have not materially improved, and there is nothing in the nature of a pre-holiday rush. As a matter of fact, at the end of last week there were forty-three vacant loading berths at the various ports in the Channel, the majority of which were at the docks at which steam coals are mainly shipped. As the result of week-end arrivals, the position on Monday was better as the number of vacant loading berths was reduced to twenty-eight, but steamers are nowadays getting such quick turns that on Tuesday the number of vacant berths was back to thirty-seven, while four steamers were waiting to load at Swansea and Port Talbot. It will thus be appreciated that with supplies of steam coal so excessive and loading berths unoccupied, the docks are capable of dealing with a much bigger volume of operations than obtains at present, and certainly no loading pressure is being experienced, such as at one time was the case on the eve of holidays. Shipments of steam and anthracite coals last week were a slight improvement upon the figures of the preceding week, the total being 396,330 tons, as compared with 388,770 tons, while for the corresponding period of last year the quantity was 463,280 tons. There have certainly been a few more inquiries on the market for comparatively small cargoes for shipment this month, but the volume of new business is small. The question whether the formation of a new Government in France will later mean a modification of that country's attitude towards the importation of coals from this country, is one that is being discussed. Hopes are entertained that, at any rate, some good will result, because the decision of the French Government that coking coals must be included in the import quota, in effect means a reduction in British exports to that country. Formerly, these particular coals were exempt from restrictions, and as the French coking coal supplies are mainly drawn from this country, the new regulation practically means a reduction in the quota. In the case of the Rosario Electricity Works, inquiry for supplies of sized coals for delivery at Rosario during 1933, it is now definite that the order for about 20,000 tons has been placed with a local firm, but it is understood that these works have also bought 10,000 tons of sized coals from Germany. It is not expected that news will come to hand with regard to the placing of the contract for 240,000 metric tons of locomotive coals for the Egyptian State Railways until immediately after the holidays. The lowest tender for the c.i.f. portion of the order was that of T. Beynon and Co., Ltd., who quoted 24s. 3d. c.i.f. Alexandria. Their price for 60,000 tons on a f.o.b. basis was 17s. 11d. per ton. Other quotations range up to 25s. 10d. c.i.f. and 18s. 8d. f.o.b. It is of interest to note that the lowest c.i.f. offer is 1s. 3d. per ton below the price of the contract which is now being carried out. The prices are regarded as very low, considering that the minimum price for the coals is 17s. 9d. and the current rate of freight for Alexandria is 6s. 10½d. to 7s.

**"Back-to-Coal" Movement.**

The "Back-to-coal" Movement was carried a step further on Thursday of last week when a conference took place in London between the committee in charge of the movement and the South Wales and Monmouthshire Members of Parliament. Mr. John Powell, Chairman of the Cardiff and South Wales Coal Exporters' Association, acted as spokesman for the committee, and said that the South Wales coal trade was faced with an emergency unparallelled in the history of the country. Since 1913 its output had fallen by nearly 20 million tons, and its exports of coal by nearly 15 million tons. In the same period the consumption of Welsh coal by the British Navy had fallen from 1·7 million tons to 160,000 tons. The result of the conference was a decision to convene a meeting of Welsh Members of Parliament for the purpose of interviewing the Prime Minister and Mr. Stanley Baldwin on the subject.

**Iron and Steel Works.**

In an interview given by Mr. Lionel D. Whitehead, of the Whitehead Iron and Steel Company, Ltd., it was disclosed that owing to the improved trade conditions, the company's Court-y-Bella works at Newport are now running overtime, and that after the Whitsuntide holidays the new mill which was put into commission a year ago will operate on a temporary double shift. There are prospects, however, if trade continues to expand, that this double shift will be permanently established, and so absorb a number of the men who became unemployed through the closing of the company's works at Tredegar. Further employment will be found later on, as it has been decided to convert the auxiliary bar mill into a completely separate unit, and to embody in it a specially designed double-strand straight continuous wire rope mill, and a start has been made with the foundations. With the completion of these extensions, the company will possess the widest range of modern high-capacity mills in Europe, capable of giving an output of 4000 to 5000 tons of light sections per week.

**Flour Mill Development.**

Big developments in the flour-milling line are in progress at Cardiff. By the end of this year Spillers, Ltd., will possess the most up-to-date flour mills in the world, as the result of the reorganisation and rebuilding now in progress. The company has decided to concentrate its operations in new buildings at a deep water site at the head of the Roath Dock, in place of the factories now situated at the East and West Docks. The company has secured from the Great Western Railway a lease of ninety-nine years of the new site where there is a jetty, 800ft. in length, thus providing facilities for the simultaneous discharge of two ocean-going steamers. As things are at present, steamers arriving with grain have to discharge it into barges in the deep-water docks, and it is then transferred to the wharf at the East and West Docks for final discharge into the company's silos and warehouses. On the new site the discharge will be effected by two 100 tons per hour pneumatic plants, travelling on rails along the jetty. The grain will then be carried by band conveyors to the receiving house, and thence to a large reinforced concrete silo capable of holding 25,000 to 30,000 tons of grain. The formal ceremony of driving the first pile of the new building took place on Friday afternoon last.

**Miners' Hours and Wages.**

The Executive of the South Wales Miners' Federation on Saturday last discussed the question of hours of work and wages and passed a resolution expressing concern with the trend of the negotiations between the Miners' Federation, the owners, and the Government, in which it appears that sufficient consideration is not being given to the deplorably low wages now received by colliery workers in the British coalfields. The Council urged the Executive Committee of the M.F.G.B. to call immediately a national conference to consider the position before the present negotiations are concluded, and recommended that the districts be consulted before they are committed to a settlement. It urged that any fresh legislation affecting the coal industry should provide for minimum wages based on the cost of living in accordance with the resolution of the national conference.

**Tin-plate Dispute Settled.**

Last week representatives of the employers and picklers held an adjourned meeting, and at the close it was announced that, subject to the approval of the men's trade union leaders, who were not present, terms of settlement had been come to. This dispute concerned a new agreement which, designed to cover all the picklers employed in the South Wales tin-plate industry, had the effect of decreasing some workers' wages and increasing others.

**Current Business.**

The tone of the steam coal market has not undergone any material change. A few new orders have made no impression on the market, as standing stocks of all qualities are very heavy. The position of some collieries from the loading point of view is not as satisfactory as it might be, owing to the fact that tonnage is not offered anything like as freely as was the case a few weeks ago. Prompt steamers of 4000 to 7000 tons are rather scarce for the Mediterranean. Dry coals continue to be relatively steadier than other descriptions. Patent fuel is quite well stemmed for early positions, but coke moves off rather slowly. Pitwood is without any improvement at 18s. 6d. to 20s.

## CATALOGUES.

BRUCE PEEBLES AND CO., Ltd., Edinburgh.—Pamphlet 26 on pole mounting transformers.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Catalogue of machines used in the sand and gravel washing industry.

THOS. ROBINSON AND SON, Ltd., Rochdale.—An illustrated brochure on planing and moulding machines.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet 824 on metal clad unit type distribution gear.

BRADLEY AND FORSTER, Ltd., Darlaston, Staffs.—Specifications of the firm's refined alloy series of pig irons.

MIRRLEES, BICKERTON AND DAY, Ltd., Hazel Grove, Stockport.—Catalogue 107–332 on marine Diesel engines.

GWYNNES PUMPS, Ltd., Hammersmith, W. 6.—Leaflet L 628/5, a specification of "Invincible" trailer fire units.

BLACKMAN EXPORT COMPANY, Ltd., 374, Euston-road, N.W. 1.—Catalogue 3203 on "Blackman" fans and accessories.

AUTOMOTIVE PRODUCTS COMPANY, Brock House, Langham-street, W. 1.—Leaflet on "Purolator" metal element filters.

JOHN ALLEN AND SONS (OXFORD), Ltd., Cowley, Oxford.—Particulars of the "Oxford Handy" light petrol road roller.

J. S. WATSON (GAINSBOROUGH), Ltd., Gainsborough.—An illustrated catalogue of light draught vessels the firm have built.

JOHN M. HENDERSON AND CO., Ltd., Aberdeen.—List 50–3 E of cable drag scrapers, and List 60–1 E on a safe load indicator for cranes.

B.E.N. PATENTS, Ltd., 92, Tottenham Court-road, W. 1.—A folder on air compressors of all sizes from 2 to 33 cubic feet displacement.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—The "A.W." small tool catalogue of stocks and dies, taps, chasers, wrenches, &c.

## LAUNCHES AND TRIAL TRIPS.

BARON ARDROSSAN, steel screw cargo steamer; built by D. and W. Henderson and Co., Ltd., to the order of Messrs. H. Hogarth and Sons, Glasgow; dimensions, 360ft. by 51ft. 6in. by 26ft.; to carry cargo. Engines, triple-expansion, 21¼in., 37in., 62in. by 42in. stroke, pressure 210 lb. per square inch; constructed by the builders; launch, May 4th.

ZENDA, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Zenda Shipping Company, Ltd., Halifax, Nova Scotia; dimensions, 248ft. by 39½ft. by 16ft. 10in.; to carry cargo. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, May 4th.

BELLE ISLE, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Newfoundland Canada Steamship Company, Ltd.; dimensions, 245ft. by 37¼ft. by 21ft.; to carry passengers. Engines, triple-expansion; constructed by the builders; trial trip, May 9th.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

HENSCHEL UND SOHN A.G., of Cassel, have re-opened all their departments for the construction of locomotives, commercial motor vehicles, motor omnibuses, motor rail coaches, and road building machinery.

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, has taken over the London warehouse business in cast iron pipes and specials of Fellowes, Williamson and Co., Ltd., Seagrave-road, Fulham, London. The warehouse will continue to be under the management of Mr. Charles Williamson.

THE BRITISH MOULDING MACHINE COMPANY, Ltd., 237, Weston-street, London Bridge, London, S.E. 1, informs us that it has been appointed the sole British agent for Gustav Zimmermann, Engineering Works, Dusseldorf, for the sale of that firm's moulding machines. Arrangements are being made to manufacture these machines in England.

MR. W. ELLERD-STYLES, M.I.E.E., A.M.I. Mech. E., 11–13, Pentonville-road, London, N. 1, advises us that he has resigned his position as managing director of Artofex Engineering Works, Ltd., which position he held since the formation of the company in 1920, and that he has now commenced business on his own account at the above-named address.

ANDREW LAING LECTURE.—As was intimated in the report of the Council of the North-East Coast Institution of Engineers and Shipbuilders at the commencement of the current Institution session, the Misses Jeannie and Catherine Laing, sisters of the late Mr. Andrew Laing, have founded a lecture to commemorate the marine engineering work of the late Mr. Laing. Time was too short to make possible the arrangement for the reading of the first Andrew Laing Lecture during the 1931–2 Institution session, and the first lecture will be delivered during the course of the 1932–3 session by the Engineer-in-Chief of the Fleet, Vice-Admiral Sir R. W. Skelton.

DRAUGHTSMEN'S PENCILS.—We have received from J. S. Staedtler, Ltd., 13, Lamb's Conduit-street, W.C. 1, some samples of "Mars Lumograph" pencils. These pencils are made in nine degrees of hardness ranging from 4H down to ExB—that is to say, to one degree beyond BB. They are distinguished from ordinary lead pencils by their covering power. The lines drawn by them are claimed to be impenetrable by sunlight or artificial light. This property enables them to be employed, in conjunction with a fairly thin transparent paper, for the preparation of drawings from which photo prints may be taken without the use of Indian ink. The various grades are intended to be used for thick or thin strokes, shading, half lights, lettering, and so forth. In spite of their covering power, we find that the pencils give lines which can be rubbed out as easily as the lines left by ordinary lead pencils and that they do not smear.

THE INSTITUTION OF CIVIL ENGINEERS: AWARDS.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during session 1931–32:—A Telford Gold Medal to Dr. C. F. Jenkin, C.B.E., F.R.S., M. Inst. C.E., St. Albans. A Telford Gold Medal to Sir Bernard D'O. Darley, C.I.E., M. Inst. C.E., Bahawalpur, India. A Stephenson Gold Medal to Mr. B. G. White, M. Inst. C.E., London. A Telford Premium jointly to Mr. H. C. Whitehead, M. Inst. C.E., Birmingham, and Mr. F. R. O'Shaughnessy, F.I.C., Birmingham. Telford Premiums to Mr. Raymond Carpmael, M. Inst. C.E., London; Mr. H. J. Deane, B.E., M. Inst. C.E., London; Mr. John Goodman, M. Inst. C.E., Skipton. A Manby Premium jointly to Mr. W. F. Stanton, B.Sc. (Eng.), Bishops Castle, and Mr. A. G. Le Clercq, M. Inst. C.E., Walton-on-Thames. A Trevithick Premium to Mr. W. C. Ash, B.Sc. (Eng.), M. Inst. C.E., Vizagapatam, India.

THE INSTITUTION OF MINING AND METALLURGY: AWARDS.—Two awards of the Gold Medal of the Institution of Mining and Metallurgy, the highest distinction in its power to confer, have been made by the Council:—(*a*) To Sir H. C. Harold Carpenter, F.R.S., in recognition of his eminent services in the advancement of metallurgical science and technology; (*b*) Dr. Thomas A. Rickard, in recognition of his services in the general advancement of mining engineering, with special reference to his contributions to technical and historical literature. The following awards have also been made:—The Consolidated Gold Fields of South Africa, Ltd., Gold Medal to Mr. P. J. Crowle, for his investigations on ground movement and methods of support in deep mines (Kolar Goldfields); The Consolidated Gold Fields of South Africa, Ltd., Premium of forty guineas to Mr. Bernard W. Holman, for his work on flotation reagents; the William Frecheville Student's Prize of ten guineas to Mr. Gilbert F. Hatch, for his paper on "Check Sampling of Diamond Drill Holes at the Trepca Mines, Jugoslavia."

STEEL DUMPING IN AMERICA.—According to Mr. E. J. Kulas, president of the Otis Steel Company, an increase of 50 per cent. in imports of iron and steel products into the United States in March, compared with February, shows the urgent necessity for emergency legislation to check the dumping of steel on American shores by Europeans, if the domestic market is not to be seriously affected. "Compared with March, 1931, imports of steel actually have gained, while exports of American steel have dropped 55 per cent. in the same period," Mr. Kulas said. "This situation is due to a combination of tariff barriers abroad and to depreciated currencies of countries that have abandoned the gold standard. Great Britain has just increased tariff duties on iron and steel imports to that country from 10 to 33 per cent. This is in addition to the approximate 30 per cent. depreciation in British currency, which makes it hard to sell to British buyers while increasing their advantage as sellers. The British tariff is directed at Continental steel makers as well as at American. Finding their markets closed to them in Great Britain, Continental producers are dumping their steel products on American shores. This dumping is threatening to undermine efforts to bring recovery in the American steel industry."

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| (1) Native | 16/6 to 20/- |
| (1) Spanish | 17/- to 22/6 |
| N.E. COAST— | |
| Native | 18/- to 21/- |
| Foreign (c.i.f.) | 15/6 |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 3 8 6 | — |
| No. 1 Foundry | 3 12 0 | — |
| No. 3 Foundry | 3 9 6 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 3 3 6 | 3 3 6 |
| No. 1 | 3 4 0 | 3 4 0 |
| Cleveland— | | |
| No. 1 | 3 1 0 | 3 1 0 |
| Siliceous Iron | 3 1 0 | 3 1 0 |
| No. 3 G.M.B. | 2 18 6 | 2 18 6 |
| No. 4 Foundry | 2 17 6 | 2 17 6 |
| No. 4 Forge | 2 17 0 | 2 17 0 |
| Mottled | 2 16 6 | 2 16 6 |
| White | 2 16 6 | 2 16 6 |
| MIDLANDS— | | |
| (c) Staffs.— | (*Delivered to Station*). | |
| All-mine (Cold Blast) | — | — |
| North Staffs. Forge | 3 1 0 | — |
| „ „ Foundry | 3 6 0 | — |
| (c) Northampton— | | |
| Foundry No. 3 | 3 2 6 | — |
| Forge | 2 17 6 | — |
| (c) Derbyshire— | | |
| No. 3 Foundry | 3 6 0 | — |
| Forge | 3 1 0 | — |
| (3) Lincolnshire— | | |
| No. 3 Foundry | — | — |
| No. 4 Forge | — | — |
| Basic | — | — |
| (4) N.W. COAST— | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c) | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 9 15 0 | 9 5 0 |
| Best | — | — |
| N.E. COAST— | | |
| Iron Rivets | 11 5 0 | — |
| Common Bars | 9 5 0 | — |
| Best Bars | 10 5 0 | — |
| Double Best Bars | 10 15 0 | — |
| Treble Best Bars | 11 5 0 | — |
| LANCS.— | | |
| Crown Bars | 9 15 0 | — |
| Second Quality Bars | 8 5 0 | — |
| Hoops | 12 0 0 | — |
| S. YORKS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 15 0 | — |
| Hoops | 12 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 9 0 0 to 9 15 0 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 8 5 0 | — |
| Gas Tube Strip | 10 10 0 | — |

## STEEL. (*d*)

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates (Marine) | 9 0 0 | 8 10 0 |
| „ „ (Land) | — | — |
| Ship Plates, ½in. and up | 8 15 0 | 7 15 0 |
| Sections | 8 7 6 | 7 7 6 |
| Steel Sheets, ¼in. | 7 15 0 | 7 15 0 |
| Sheets (Gal. Cor. 24 B.G.) | 10 15 0 | 10 0 0 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 8 15 0 | 7 15 0 |
| Angles | 8 7 6 | 7 7 6 |
| Boiler Plates (Marine) | 10 10 0 | — |
| „ „ (Land) | 10 0 0 | — |
| Joists | 8 15 0 | 7 7 6 |
| Heavy Rails | 8 10 0 | — |
| Fish-plates | 12 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5s. |
| Hard Billets | 7 2 6 | — |
| Soft Billets | 5 10 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 8 5 0 | — |
| Light Rails | 8 10 0 to 8 15 0 | — |
| Billets | 6 10 0 to 9 0 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 7 6 | — |
| „ (Small Round) | 7 0 0 | — |
| Hoops (Baling) | 10 0 0 | 9 15 0 |
| „ (Soft Steel) | 9 0 0 | 8 15 0 |
| Plates | 8 17 6 to 9 2 6 | — |
| „ (Lancs. Boiler) | 8 12 6 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 9 2 6 (basis) | — |
| Hard Basic | 8 2 6 and 8 12 6 | — |
| Intermediate Basic | 6 12 6 and 7 2 6 | — |
| Soft Basic | 6 0 0 | — |
| Hoops | 9 10 0 to 9 15 0 | — |
| Soft Wire Rods | 7 10 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars (all British) | 7 5 0 to 7 15 0 | — |
| Small Re-rolled Bars | 6 7 6 to 6 10 0 | — |
| Billets and Sheet Bars | 5 5 0 to 5 10 0 | — |
| Galv. Sheets, f.o.b. L'pool | 9 7 6 to 9 10 0 | — |
| (2) Staffordshire Hoops | 9 10 0 | — |
| (*d*) Angles | 8 7 6 | — |
| (*d*) Joists | 8 15 0 | — |
| (*d*) Tees | 9 7 6 | — |
| (*d*) Bridge and Tank Plates | 8 17 6 | — |
| Boiler Plates | 8 7 6 to 8 10 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 f.o.b. | 14/6 to 15/3 |
| Block Tin (cash) | 120 0 0 |
| „ (three months) | 122 0 0 |
| Copper (cash) | 29 7 6 |
| „ (three months) | 29 10 0 |
| Spanish Lead (cash) | 10 16 3 |
| „ „ (three months) | 11 2 6 |
| Spelter (cash) | 12 10 0 |
| „ (three months) | 12 16 3 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 34 5 0 |
| „ Electrolytic | 35 0 0 |
| „ Strong Sheets | 63 0 0 |
| „ Tubes (Basis Price), lb. | 0 0 9½ |
| Brass Tubes (Basis Price), lb. | 0 0 9 |
| „ Condenser, lb. | 0 0 11½ |
| Lead, English | 13 0 0 |
| „ Foreign | 11 5 0 |
| Spelter | 12 15 0 |
| Aluminium (per ton—raw ingot) | £95 |

## FERRO ALLOYS.

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 2/3½ per lb. | |
| Ferro Tungsten | 2/- per lb. | |
| Ferro Chrome, 4 p.c to 6 p.c. carbon | £25 12 6 | 7/- |
| „ „ 6 p.c. to 8 p.c. | £24 10 0 | 7/- |
| „ „ 8 p.c. to 10 p.c. | £23 15 0 | 6/6 |
| „ „ Specially Refined | | |
| „ „ Max. 2 p.c. carbon | £37 15 0 | 10/- |
| „ „ „ 1 p.c. carbon | £48 0 0 | 12/- |
| „ „ „ 0·70 p.c. carbon | £52 0 0 | 13/- |
| „ „ „ carbon free | 1/1 per lb. | |
| Metallic Chromium | 3/- per lb. | |
| Ferro Manganese (per ton) | £11 0 0 for home | |
| „ „ „ | £11 10 0 for export | |
| „ Silicon, 45 p.c. to 50 p.c. | £10 0 0 scale 5/- per unit | |
| „ „ 75 p.c. | £17 15 0 scale 7/- per unit | |
| „ Vanadium | 12/9 per lb. | |
| „ Molybdenum | 6/3 per lb. | |
| „ Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £250 to £255 | |
| Ferro Cobalt | 8/9 per lb. | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 13/- |
| „ „ Ell | 14/3 |
| „ „ Splint | 14/3 to 15/6 |
| „ „ Trebles | 11/6 |
| „ „ Doubles | 9/9 |
| „ „ Singles | 8/9 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 12/- |
| „ „ Jewel | 16/6 |
| „ „ Trebles | 12/- |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 11/- to 12/- |
| Screened Navigation | 16/6 |
| Trebles | 11/- to 13/- |
| Doubles | 10/- to 10/6 |
| Singles | 8/9 |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 11/- to 11/6 |
| Secondary Steam | 11/- |
| Trebles | 11/- to 11/6 |
| Doubles | 9/9 to 10/- |
| Singles | 8/9 to 9/- |

### (8) N.W. COAST— ENGLAND.

| | |
|---|---|
| Steams | 21/9 |
| Household | 32/6 to 51/8 |
| Coke | 20/- to 22/6 |
| NORTHUMBERLAND— | |
| Best Steams | 13/6 |
| Second Steams | 12/3 to 12/6 |
| Steam Smalls | 8/6 |
| Unscreened | 12/6 to 13/- |
| Household | 27/- to 30/- |
| DURHAM— | |
| Best Gas | 14/6 |
| Second | 13/3 to 13/6 |
| Household | 25/- to 37/- |
| Foundry Coke | 24/- |

| SHEFFIELD— | Inland. | Export. |
|---|---|---|
| Best Hand-picked Branch | 25/- to 26/- | — |
| South Yorkshire Best | 20/- to 21/- | — |
| Derbyshire Best Bright House | 20/- to 21/- | — |
| Screened House Coal | 16/- to 17/6 | — |
| Best Screened Nuts | 16/- to 17/- | — |
| Small Screened Nuts | 13/6 to 14/6 | — |
| Yorkshire Hards | 16/- to 18/- | — |
| Derbyshire Hards | 16/- to 18/- | — |
| Rough Slacks | 8/6 to 9/6 | — |
| Nutty Slacks | 7/- to 8/6 | — |
| Smalls | 5/- to 6/- | — |

Blast-furnace Coke (Inland) 12/- to 12/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 15/6 to 17/6

### (9) SOUTH WALES.

| | |
|---|---|
| CARDIFF— | |
| Steam Coals: | |
| Best Smokeless Large | 19/6 to 19/9 |
| Second Smokeless Large | 18/9 to 19/6 |
| Best Dry Large | 19/- to 19/6 |
| Ordinary Dry Large | 17/9 to 18/3 |
| Best Black Vein Large | 18/3 to 18/6 |
| Western Valley Large | 17/9 to 18/- |
| Best Eastern Valley Large | 17/7½ to 17/9 |
| Ordinary Eastern Valley Large | 17/3 to 17/6 |
| Best Steam Smalls | 13/- to 13/6 |
| Ordinary Smalls | 11/- to 13/- |
| Washed Nuts | 19/- to 25/- |
| No. 3 Rhondda Large | 19/6 to 19/9 |
| „ „ Smalls | 15/- to 16/- |
| No. 2 „ Large | 17/- to 17/3 |
| „ „ Through | 15/6 to 16/- |
| „ „ Smalls | 14/- to 14/3 |
| Foundry Coke (Export) | 22/6 to 36/6 |
| Furnace Coke (Export) | 17/- to 18/- |
| Patent Fuel | 19/- to 19/6 |
| Pitwood (ex ship) | 19/6 to 20/6 |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Big Vein Large | 36/- to 38/6 |
| Seconds | 27/- to 32/6 |
| Red Vein | 22/6 to 27/6 |
| Machine-made Cobbles | 41/6 to 48/6 |
| Nuts | 40/- to 48/6 |
| Beans | 28/6 to 32/6 |
| Peas | 19/- to 21/- |
| Breaker Duff | 8/6 to 9/6 |
| Rubbly Culm | 8/3 to 8/9 |
| Steam Coals: | |
| Large | 20/- to 20/6 |
| Seconds | 18/- to 20/- |
| Smalls | 11/6 to 13/- |
| Cargo Through | 16/- to 17/6 |

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

# French Engineering Notes.

*(From our own Correspondent in Paris.)*

### The Engineering Trades.

BECAUSE they can see no other hope in the immediate future, manufacturers look with confidence to the national programme of public works as a means of enabling them to tide over the period of industrial depression; but they are, nevertheless, uneasy at the delay in the distribution of work, the cause of which is obviously the difficulty of financing the undertaking. The funds have been voted by Parliament, and the State can only raise them by the issue of Treasury bonds, which, it was stated a little while ago, were on the point of being put on the market. So far, nothing appears to have been done to secure money from the public, but a good deal of work has, nevertheless, been put in hand, notably road construction, though the effects of public undertakings on industry are much less pronounced than had been anticipated. It is hoped that when the new Government is formed the public works programme will be carried through with more vigour. The only firms which have much to do are those engaged on contracts from the home and foreign Governments. There is some complaint that one manufacturer has purchased powerful hydraulic presses in Germany for the execution of a contract for shells for naval guns. It is affirmed that such presses could very well have been supplied by French makers. On the whole, the works for national defence and the equipments of ports are providing employment to specialised firms, though even for such contracts competitive prices have to be accepted, and in their anxiety to get business manufacturers are prepared to take much lower prices than they would accept under normal conditions. The railway companies are making inquiries for rolling stock, and the Nord Company will shortly distribute orders for 2800 trucks and vans and 140 metallic coaches. There is also a fair number of rail motor coaches on order, but there is some difficulty in getting suitable oil engines of the solid injection type from French makers, who are not yet supplying sufficiently powerful engines for rail traction. Many of them build engines under foreign licences, and some are preparing to construct engines to their own designs, though it may be a considerable time before this market can be freed of its dependence on foreign oil engines.

### Wages.

The problem of wages has not been solved by the International Labour Bureau at Geneva, nor does there appear to be much prospect of anything being done to fix internationally a comparative scale of wages on the basis of an acceptable standard of living in the different European countries. Data are being collected with the idea of establishing some such basis, but the problem is so inextricably complicated that it is doubtful whether any satisfactory arrangement will be reached. Meanwhile, French manufacturers have been driven to the necessity of getting wages back to the pre-war level in relation to the present currency values. When so many firms find it difficult to run even thirty hours a week production costs must come down to meet competition for business, and in some cases there have been drastic cuts in the salaries of staffs, and efforts are being made to bring down the wages of operatives to the coefficient of 5, which means that wages will be on the same level as the gold franc before the inflation. Until recently, wages have been paid at a coefficient of more than 6. On account of the closing of some foreign markets to French produce, there has been some decline in the prices of commodities at home, and as those prices always advance with higher wages, it is hoped that they will decline with a more normal rate of pay to wage earners.

### Economic Reprisals.

The practice of the Government in instituting reprisals against foreign countries without taking into account the effect which they are likely to have on national interests has aroused a protest from the Union des Chambres de Commerce Maritimes which points to the recent decree prohibiting the transit through France of agricultural produce from Great Britain and Spain as an example of the damage done to home industries by measures of that kind. So far as Spain is concerned the prohibition merely had the effect of diverting the traffic by British ships to the North of Europe. The French Government soon saw the mistake it had made and cancelled the prohibition, but the Union des Chambres de Commerce Maritimes states that damage has already been done, and that while the French ports and railways may get back the Spanish traffic, it will probably not be under the same conditions as formerly. These inexplicable decrees do more harm to home interests than to foreign countries. They are not the result of a well-ordered policy, and it is probable that experience will show the French authorities the danger and futility of resorting to such reprisals.

### Goods Traffic Improvements.

Not only has road traction introduced a perilous element of competition with the railways, but the improvements to canals and the acceleration of traffic by electrical haulage and motor barges threaten to compromise seriously the railway transport of coal from the northern collieries. The canals are more under the fostering influence of the State than the railways. The inland water transport companies complain that they cannot compete with the railways until more is done to increase the waterway facilities by reconstructing locks and creating ports for the more rapid movement of bigger barges. These improvements are being carried out under the national programme of public works, and when they are completed the competition with railways is likely to become more severe. At the same time, the railway companies are required by law to equip all goods trains with continuous brakes, though, so far, the work has only been partially carried out; but on the Nord railway coal trains with continuous brakes are now running direct from Lens to Paris. They are drawn by the new type of superheated steam locomotives. The cost is reduced by the accelerated service economising the time of those running the train, as well as by a lower consumption of coal.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

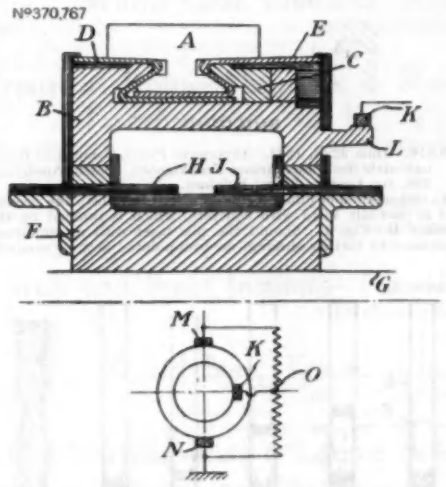
*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## DYNAMOS AND MOTORS.

370,767. July 9th, 1931.—COMMUTATORS FOR DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The bars A of the high-voltage commutator described in this specification are assembled between a drum B, and a ring C, from which they are insulated by the insulation elements D and E. The drum B is insulated from the sleeve F, by which it is keyed on the shaft G by insulation elements H and J. The shaft—that is to say, the body of the machine—may also be insulated from earth. Between the bars of the commutator and the body of the machine there are thus at least two insula-

Nº370,767

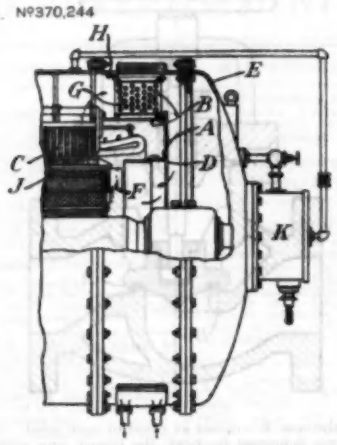



tions D E and H J in series. The potential of the drum B is positively fixed at the value for which the two insulations have been provided. A contact brush K may, for instance, be arranged on the cylindrical section L of the drum B, the contact brush being connected to a known point of potential. This known point of potential may be taken on a resistance O connected between the two principal brushes M and N of the machine, the resistance having an ohmic value sufficiently low for the variations in the insulation resistances of the elements D E and H J not to influence appreciably the potential of the drum B.—*April 14th*, 1932.

370,244. May 28th, 1931.—DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

This invention relates to totally enclosed dynamo-electric machines of the type in which a cooling gas such as hydrogen, air, or other suitable gas, is circulated within the machine and over the surfaces of coolers which carry away the heat absorbed by the circulating cooling gas. A simple and compact arrangement of coolers for cooling the gas is provided by arranging an annular baffle ring A at the end of the stationary member. This baffle has a cylindrical portion B extending to the end of the member adjacent the outer periphery of the core

Nº370,244

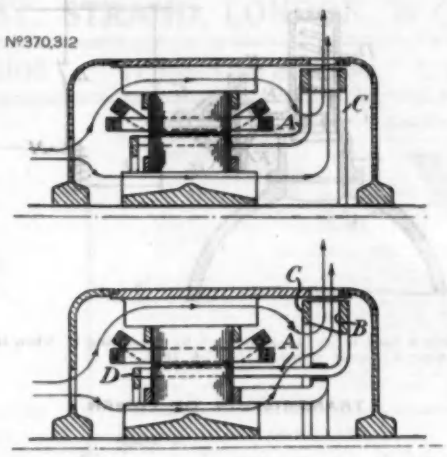



structure C, and a cylindrical portion D at the inner periphery, terminating adjacent to the impeller blades carried by the pole pieces of the rotatable member, so that the cooling gas is directed from the outer periphery of the core structure of the stationary member through the end head E and into the impeller blades F carried by the revolving pole pieces. Arcuate coolers G are arranged between the cylindrical extension B of the baffle ring and the removable section H of the enclosing housing of the machine. The machine housing is filled with hydrogen gas, which is circulated within the machine by the action of the pole pieces J and the impeller blades F. The slip rings are enclosed in the casing K.—*April 7th*, 1932.

370,312. August 26th, 1931.—VENTILATING DYNAMO-ELECTRIC MACHINES, *International General Electric Company Incorporated, of 120, Broadway, New York, U.S.A.*

The object of this invention is efficiently to cool both the stator and rotor of a squirrel-cage motor that has to start against heavy loads in which the rotor bars are provided with blades B of high resistance material, and cause the air to flow in the direction shown by the arrows, the free end of the blades being connected to a short-circuiting ring C. At the other end the bars are likewise connected to a short-circuiting ring D. This arrangement of the blades allows the air heated by the rotor to be rapidly removed and to flow at a suitable distance from the stator. The general principle is known, but, according to the invention, the flow of air through the stator is facilitated by

Nº370,312

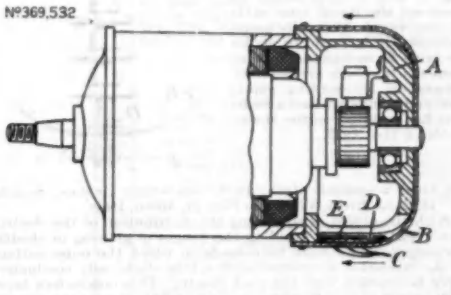



extending the rotor bars A beyond the short-circuiting ring C, instead of the vertical parts of these bars being on the left of this ring in accordance with the usual arrangement shown in the upper illustration. The radially extending bars obviously do not offer resistance to the flow of air through the stator, which is, therefore, adequately ventilated.—*April 7th*, 1932.

369,532. October 14th, 1931.—ELECTRICAL MACHINES SUITABLE FOR USE WITH MOTOR VEHICLES, Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

With the object of providing ventilation for electrical machines and protecting them against dust a cover is fitted, as shown at A. The cover is provided with several arms arranged so that none of them is near the lowest part of the machine. Over this cover there is a protective cap B. At the lower part of this

Nº369,532



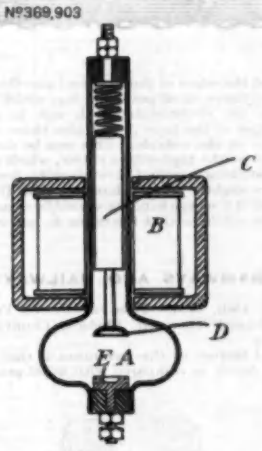

cap there are small openings C, and above these openings there is a sheet of felt D, which is held in position by a perforated metal plate E, riveted to the sheet metal cap B. Apart from protecting the machine against the penetration of dust, the arrangement allows water formed by condensation to pass out of the machine. The invention is particularly applicable to dynamos fitted to mechanically propelled vehicles.—*March 24th* 1932.

## SWITCHGEAR.

369,903. November 29th, 1930.—ELECTRICAL SWITCHES, Matt Payne, of 50, Hook-road, Surbiton, Surrey.

A switch constructed in accordance with this invention consists of a vessel A filled with oil, or an inert gas. Above the

Nº369,903

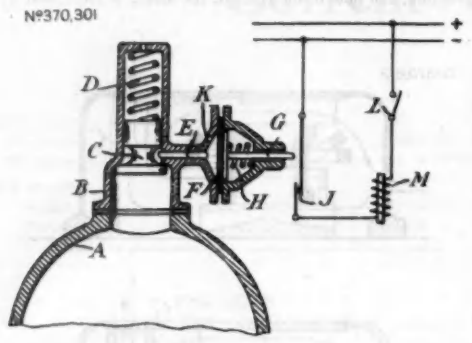



vessel A is an electro-magnet B with a plunger C, and a contact D, and when the electro-magnet is energised the plunger C and contact D are pulled down and the contacts D and E are closed.—*March 29th*, 1932.

370,301. August 7th, 1931.—GAS BLAST ELECTRIC CIRCUIT BREAKERS, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

A scheme is described in this specification for preventing the operation of a gas blast circuit breaker when the gas pressure is too low. The vessel A is fitted with a minimum pressure valve B, the piston C of which is held closed by the air pressure in the vessel A. If, however, the pressure falls below a predetermined limit, the spring D presses the valve C down and allows air to act on the diaphragm F by passing through the passage E. The diaphragm forces the spindle G forward against the action of the spring H and opens the contacts J, when the switch can no longer be opened by closing the contacts at L by the

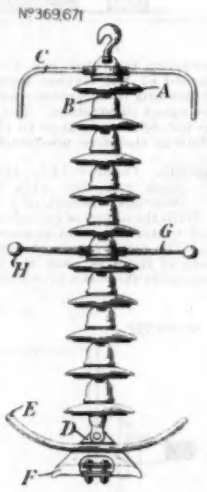
releasing magnet M. But if the pressure in the vessel A rises again, the valve C closes and after the air acting on the diaphragm has escaped through the small opening K, the diaphragm is




pressed back to its initial pressure by the spring H, when the contact J is again closed.—*April 7th*, 1932.

## TRANSMISSION OF POWER.

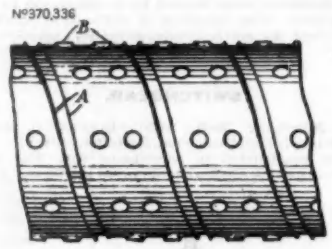
369,671. December 31st, 1930. —Devices for Indicating when a Flash-over has Occurred Across an Insulator or Chain of Insulators, Bullers, Ltd., and Hubert Charles Rayner Dagnall, both of 6, Laurence Pountney-hill, London, E.C. 4.




Each insulator in the chain is provided with a metal cap A, with a metal pin B attached to the adjacent insulator. The metal cap of the upper insulator has extending horns C. The pin of the lowest insulator has a bracket D attached to an arcing ring E and a cable clamp F. There are also metal arms at G. In the event of a discharge occurring, it is bound to strike the arms G and the indicating members H, which are made of a metal of low melting point, fuse, and so indicate that a flash-over has occurred on the chain. —*March 31st*, 1932.

370,336. September 28th, 1931.—Electric Cables, Societa Italiana Pirelli, Via Fabio Filzi 21, Milan, Italy.

With the object of equalising the distribution of the electrostatic field and thus avoiding the danger of glowing or electric discharges, cables have been made in which the outer surface of the insulation is covered with a thin electrically conductive layer in contact with the lead sheath. This conductive layer may consist of metallised paper tape, and to allow of the impregnation of the cable the tape is usually perforated so that the impregnating compound may readily pass through it. There

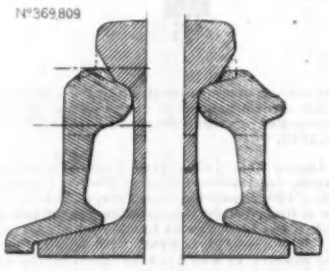



is a danger that the edges of the tape and also those of the holes in the tape may have small points or jags which may alter the distribution of the electrostatic field, and to overcome this trouble the edges of the tape A and also those of the holes B are folded over on the outside. This can be done by making the perforations in the tape with a cutter, which cuts somewhat bluntly, or by striking a second blow after the first with another cutter having a slightly greater diameter than that of the first cutter. The lay of the tape winding should be equal to or slightly greater than its width, so that the edges do not overlap.—*April 7th*, 1932.

## TRAMWAYS AND RAILWAYS.

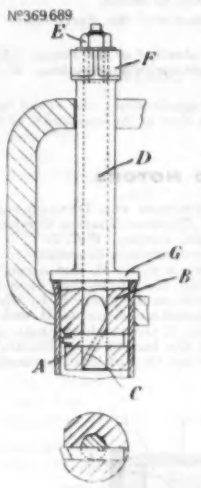
369,809. June 15th, 1931.—Fish-plates for Flat-bottomed Rails, McLeod Thomson, Chelsea, County of Atlantic, New Jersey.

The essential feature of this invention is that the fish-plate is increased in depth, as compared with usual practice, in order




to make it as stiff as possible. It is for use with what is described in America as a "head-free rail," of the contour shown in the drawings. The top of the fish-plate is extended to embrace the head of the rail, but is stopped short just clear of the wheel flanges of the rolling stock. A number of alternative designs are illustrated in the specification, from which we select two examples.—*March 31st*, 1932.

## MACHINE TOOLS AND SHOP APPLIANCES.



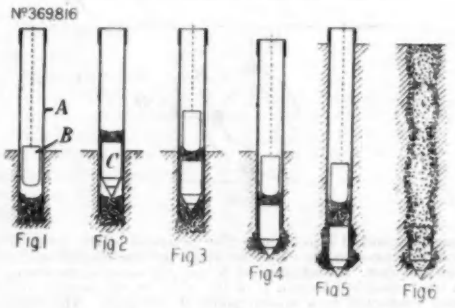

369,689. January 14th, 1931.—Tube Cutters, F. Squirrell, 15, Harrington-road, South Norwood, S.E. 25.

This tool is intended for cutting out defective tubes in water-tube boilers, and for similar purposes. The cutting tool A is held in the body B and is fed up to its work by the diagonal spline C on the spindle D, which is operated by the nut E. The tool is rotated by means of a spanner on the hexagon F, and has a flange G which determines its position with regard to the end of the tube.—*March 31st*, 1932.

## BUILDING.

369,816. June 22nd, 1931.—Concrete Piles, Compagnie Internationale des Pieux Armes Frankignoul, Société Anonyme, 196, rue Gretry, Liége, Belgium.

In this method of piling a tube A is first sunk into the ground and is partially filled with concrete, which is tamped by the monkey B—Fig. 1. Should the pile meet with an abnormal resistance to further sinking, an iron-pointed slug of concrete

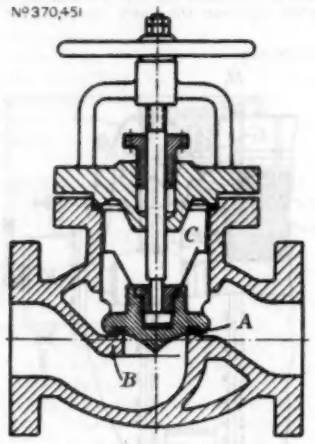



C is placed in the tube, a cushion of concrete is placed on the tops and driving is continued—Fig. 2. The slug is driven through the original concrete, and makes a way for the further sinking of the tube—Figs. 3, 4, and 5. The tube is then gradually withdrawn and at the same time further concrete tamped in to complete the pile—Fig. 6.—*March 31st*, 1932.

## MISCELLANEOUS.

370,451. January 8th, 1931.—Fluid-tight Valves, especially for High Pressures and Temperatures, Johann Zagorski, of Kantstrasse 33, Berlin, Germany.

A valve for high pressures and temperatures constructed in accordance with this invention has a soft copper or other ring




A, whilst the seat B consists as usual of hard steel. If any of the parts are deformed by heat, the plastic ring adapts itself to the harder member B, with a tight fit. Guiding ribs C slide in grooves in the valve top, so as to prevent rotary movement of the part carrying the ring B.—*April 8th*, 1932.

369,863. August 31st, 1931.—Apparatus Carrying High Voltage, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to foundations for electric machines and apparatus carrying high voltage. For certain power generating or transmission plant working at high voltages, such, for example, as direct-current machines in series or mercury vapour rectifiers, it is necessary to mount the sets on insulators. Endeavours have been made to meet the requirements by means of foundations of brickwork and asphalt or with the aid of porcelain elements or similar means, but such foundations are not sufficiently stable, and for plant of considerable outputs they are found to be too expensive. According to the invention, these drawbacks are overcome by building up the foundation for H.T. electric machines or apparatus of paper bricks soaked with a suitable insulating medium, such, for example, as asphalt. Such foundations are capable of withstanding mechanical stresses and do not change their insulative resistance, even under unfavourable climatic conditions.—*March 31st*, 1932.

# Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### TO-DAY.

British Association of Chemists: London Section.—The annual general meeting at the Broad-street Station Restaurant, London, E.C. 7 p.m. This meeting is taking the place of that announced for May 6th, 1932.

Institution of Electrical Engineers: Scottish Centre.—At the Cowdray Hall, Aberdeen. Faraday Lecture, "Everyday Uses of Electricity," by Professor J. K. Catterton-Smith. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Broadcasting," by Sir John C. W. Reith. 9 p.m.

### TO-DAY to WEDNESDAY, MAY 18TH.

Paris Trade Fair.—Exhibition Park, Porte de Versailles. Open daily. London office of the Fair, 143, Fleet-street, E.C. 4.

### SATURDAY, MAY 14TH.

Institution of Electrical Engineers: Scottish Centre.—Excursion from Aberdeen to Braemar. Leave Caledonian Hotel, Aberdeen, 9.30 a.m.

### WEDNESDAY, MAY 18TH.

Electroplaters' and Depositors' Technical Society.—Northampton Polytechnic Institute, St. John-street, London, E.C. 1. "The Adhesion of Electro-deposited Nickel to Brass," by Mr. A. W. Hothersall. 7.45 p.m.

National Institute of Industrial Psychology.—At the London School of Economics and Political Science, Aldwych, W.C.2. "Psychological and Social Factors in Business Rationalisation: The Advantages of Rationalisation," by Dr. Charles S. Myers. 5.30 p.m.

Royal Microscopical Society.—B.M.A. House, Tavistock-square, London, W.C. 1. Meeting at 5.30 p.m.

### FRIDAY, MAY 20TH.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Faraday at the Sign of the Hexagon: Coal Colour and Constitution," by Professor H. E. Armstrong. 9 p.m.

### SATURDAY, MAY 21ST.

Institution of Municipal and County Engineers.—Yorkshire District meeting, to be held at Dewsbury.

### WEDNESDAY, MAY 25TH.

British Science Guild.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Polar Lights," by Professor Sydney Chapman, F.R.S. 4.30 p.m.

### THURSDAY, MAY 26TH.

Royal Aeronautical Society.—In the Science Museum, Aeronautical Section, South Kensington, S.W. 7. Twentieth Wilbur Wright Memorial Lecture, "New Methods of Research in Aeronautics," by Mr. H. E. Wimperis. Annual Council dinner. Reception and conversazione.

### FRIDAY, MAY 27TH.

Institute of Transport.—Joint meeting with the Town Planning Institute and the National Housing and Town Planning Council. "Planning and Transport," by Mr. G. L. Pepler. 6 p.m.

### SATURDAY, MAY 28TH.

Institution of Municipal and County Engineers.—Meeting at Whitby. Royal Hotel, Whitby. 1 p.m.

### WEDNESDAY, JUNE 1ST.

Institution of Electrical Engineers: North Midland Students' Section.—Visit to Hull Docks. Leave General Post Office, City-square, Leeds, 9 a.m.

### MONDAY, MAY 30TH, to FRIDAY, JUNE 3RD.

Institution of Electrical Engineers.—Summer meeting at the North Midland Centre. For provisional programme see page 379.

### WEDNESDAY to SATURDAY, JUNE 1ST to 4TH.

Institute of Transport.—Congress at Buxton. For programme see page 523.

### TUESDAY to FRIDAY JUNE 7TH to 10TH.

Institute of British Foundrymen.—Annual Conference at Newcastle-upon-Tyne. Particulars may be obtained from the Hon. Conference Secretary, Mr. J. W. Eckford, 4, Mosley-street, Newcastle-upon-Tyne.

### WEDNESDAY to FRIDAY, JUNE 15TH to 17TH.

Institution of Mining Engineers.—Summer meeting at Sheffield. Wednesday, general meeting at the Royal Victoria Hotel, Sheffield. Address of welcome by the Lord Mayor of Sheffield. Presentation and discussion of papers, 11 a.m. The meeting will be adjourned at 1 p.m. and resumed at 2.30 p.m. Reception of members and ladies by the Lord Mayor and the Lady Mayoress of Sheffield at the Town Hall, 4.30 p.m. Reception of members and ladies at the Royal Victoria Hotel, Sheffield, by the President and Council of the Midland Institute of Mining Engineers, followed by a cabaret show and dance, 8.30 p.m. Thursday, visits to various works, 10.30 a.m. Institution of Mining Engineers' dinner at the Royal Victoria Hotel, Sheffield, followed by informal dance, 7.30 p.m. Friday, visits to various works, 11 a.m.

### TUESDAY to SATURDAY, JUNE 21ST to 25TH.

British Waterworks Association.—Bournemouth. Annual general meeting and conference. For programme see page 422.

### SUNDAY to SUNDAY, JUNE 26TH to JULY 10TH.

World Power Conference.—Sectional meeting in Scandinavia. For provisional programme see page 405.

### FRIDAY, JULY 1ST.

Overhead Lines Association.—Summer meeting at Chesham. For provisional programme see page 513.

### MONDAY to TUESDAY, JULY 4TH to 12TH.

International Electrical Congress, 1932.—Particulars may be obtained by intending British visitors from the Secretary of the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2.

### TUESDAY, JULY 5TH, to SATURDAY, JULY 9TH.

Royal Agricultural Society of England.—Royal Show at Southampton.